OCTOBER, 1933.

GENERAL PHYSICS.

ADSORPTION.

4301. Influence of Combined Oxygen on the Determination of the Vapour Isothermals on Porous Solids. Part II. L. J. Burrage. *J. Phys. Chem.* 37. *pp.* 735–744, *June,* 1933.—An extension of earlier work on the adsorption of vapours by charcoal. [See Abstract 3272 (1933)]. The adsorption isothermals of carbon tetrachloride and benzene on silica gel have been determined at 25° C. The amount of carbon tetrachloride taken up by silica gel gradually decreases with successive sorption or desorption experiments. This is attributed to the continuous removal of structural water from the gel by the carbon tetrachloride. Benzene which is a less powerful agent for the removal of water, is sorbed to a greater extent with successive sorption and desorption experiments. Although the isothermals for carbon tetrachloride are not reproducible the pressures at which discontinuities occur in the isotherms are the same. F. J. W.

4302. Adsorption of Gases at Low Pressures by Carbon and Silicic Acid Gel. O. Winkler. *Zeits. f. techn. Physik,* 14. 8. *pp.* 319–332, 1933.—The adsorption of nitrogen and hydrogen by certain commercial brands of carbon and silicic acid gel is investigated at pressures between 10^{-2} and 10^{-6} mm. Hg. The apparatus used has no taps (grease vapours absent) and employs Pirani-Hale and ionisation manometers in place of a McLeod gauge (mercury vapour absent). The preliminary heating of the substance under investigation is performed in a small h.f. furnace within the apparatus. The temperature of the measurements is generally − 183° C (liquid oxygen), though in a few cases it is − 196° C (liquid nitrogen). The results are represented graphically, the volume of gas adsorbed as the temperature is reduced from air temperature to that of the experiment being plotted against the final gas pressure. In the case of nitrogen the adsorption process is non-reversible, *i.e.,* different isotherms are obtained according as to whether the pressure is progressively increased or decreased. The curves for hydrogen, on the contrary, are reversible in character. Measurements are also made of the variation of pressure with time during the period required for the attainment of equilibrium after the application or removal of the low-temperature bath. Characteristic differences of behaviour between nitrogen and hydrogen are observed. The concluding section of the paper gives a discussion of the bearing of the results upon practical applications. L. A. W.

See also Abstract 4380.

ATOMIC AND MOLECULAR STRUCTURE.

4303. Binding Forces in the Alkali and Alkaline Earth Metals According to the Free Electron Theory. O. K. Rice. *J. Chem. Phys.* 1. *pp.* 649–655, *Sept.,* 1933.—Theoretical metals are pictured as positively charged ions surrounded by electrons and having a specific ionic volume into which the electrons cannot penetrate. The attractive potential is calculated. A relation is found between total energy of the metal and its atomic volume. The former is the sum of the energy of ionisation of gaseous atoms and their energy of sublimation ; so that the latter can be calculated from experimental data. For the alkali and alkaline earth metals the agreement between observed and calculated values is good. Compressibility is also calculated for the alkali metals, but with less good agreement with the experimental data. A. S. C. L.

4304. Relative Abundance of Hydrogen Isotopes. W. Bleakney and A. J. Gould. *Phys. Rev.* 44. *pp.* 265–268, *Aug.* 15, 1933.—Samples of rain water collected at Princeton were decomposed by repeated passage over iron turnings heated to 510° C. The hydrogen formed was analysed with a mass-spectrograph to determine the abundance ratio $H^2 : H^1$. The first fraction of hydrogen to be liberated from a particular sample of the water yielded a value given by $H^2 : H^1 = 1 : 6500$ while the last fraction gave 1 : 4500. Another sample was prepared in which the decomposition was carried to completion and all of the hydrogen collected. The abundance found in this sample was 1 : 5000. It is believed that this last figure represents a close approximation to the true abundance ratio for natural hydrogen. The value 1 : 30,000 previously reported by Bleakney for electrolytic hydrogen may be in agreement with these measurements when account is taken of the separation introduced by the electrolysis. A fairly extensive Bibliography is given of recent work on the hydrogen isotopes. AUTHORS.

4305. Atomic and Molecular Forms of the Hydrogen Isotopes. H. S. Taylor and H. Eyring. *Am. Phil. Soc., Proc.* 72. *pp.* 255–264, 1933.—A brief review is first given of the experimental and theoretical work on hydrogen since 1912, and then follows a summary of the authors' investigations on the production of the heavy hydrogen isotope and an outline of the results obtained for the ortho-para conversion at paramagnetic surfaces. H. H. Ho.

4306. Isotopes of Cobalt by the Magneto-Optic Method. T. R. Ball and S. S. Cooper. *Am. Chem. Soc., J.* 55. *pp.* 3207–3210, *Aug.*, 1933.—By Allison's magneto-optic method, two new isotopes of cobalt, at 57 and 58, have been recorded, 58 being the less abundant, whilst both are far less so than Aston's isotope at 59. A reading attributed by Allison and Murphy to nickel is now shown to be due to cobalt, and a new one is made for nickel, but their other readings for nickel are confirmed. C. B. A.

4307. Molecular Structure of Coordination Compounds of Platinum and Palladium. E. G. Cox and G. H. Preston. *Chem. Soc., J. pp.* 1089–1093, *Aug.*, 1933.—X-ray examination of various platinum and palladium amines furnishes further evidence of the planar distribution of platinous and palladous valencies and, in addition, leads to the conclusion that the valencies of the metal atom are not all crystallographically equivalent, but are differentiated into pairs, only those valencies which are *trans* to each other being equivalent. This applies to all the compounds examined except ammonium chloropalladite, *i.e.*, to all those in which the metal atom is the centre of a positive or neutral complex. The differentiation is undoubtedly intimately connected with the distribution of shared electrons, and is presumably due to slight differences in energy between the various sub-groups in the same principal quantum group of the central atom. Thus the difference between the pairs of

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valencies lies in the strength of the bond, and is not a difference of type, so that it cannot be expected to give rise to isomerism, but should be of importance in problems of elimination and substitution. [See Abstract 35 (1933)]. T. H. P.

4308. Determination of the Structures of Methane Derivatives by the Electron Diffraction Method. R. W. Dornte. *J. Chem. Phys.* 1. *pp.* 630–633, *Sept.*, 1933.—The molecular structures of several bromine and iodine derivatives of methane have been determined by the electron diffraction method. For tertiary butyl bromide it has been found that the tertiary carbon atom has the tetrahedral angles between the valence bonds, and the interatomic distances are: tertiary C — methyl C 1·55Å and tertiary C — Br 2·06Å. In methyl bromide and iodide the C — X distances are 2·06 and 2·28Å, respectively. In methylene bromide and iodide it has been found that the angle between the C — X bonds is 125° and the interatomic distances are: C — Br 2·023, Br — Br 3·61, C — I 2·28 and I — I 4·06Å. In bromoform the angles formed by the C — Br bonds are 115°, and the interatomic distances are: C — Br 2·05 and Br — 3·46Å. AUTHOR.

4309. Revision of the Atomic Weight of Potassium. G. P. Baxter and W. M. MacNevin. *Am. Chem. Soc., J.* 55. *pp.* 3185–3190, *Aug.*, 1933.—In view of discrepancies in earlier published results by various investigators, a series of 33 analyses of potassium chloride were made by comparison with silver, using potassium salts of different origin. The mean value found for the atomic weight was 39·094. N. M. B.

4310. Atomic Weight of Less Volatile Potassium Prepared by Hevesy. G. P. Baxter and C. M. Alter. *Am. Chem. Soc., J.* 55. *pp.* 3270–3271, *Aug.*, 1933.—The atomic weights of common potassium and the heavy potassium concentrated by ideal distillation by Hevesy and Lögstrup were found to be 39·096 and 39·109 respectively, indicating 7·3 % of K^{41} in the heavy potassium. N. M. B.

See also Abstracts 4342, 4385, 4443, 4457, 4465, 4506, 4531, 4648, 4707.

COLLOIDS.

4311. Mechanical Properties of Disperse Systems. Part I. Deformations of Building Ground by Pressure. G. I. Pokrowski and W. G. Bulytschew. *Kolloid Zeits.* 64. *pp.* 175–178, *Aug.*, 1933.—From statical considerations it is possible to determine the general character of the relationship between force and deformation for bodies consisting of structural elements, such as soils, building ground, etc. The relation thus derived is in agreement with observed results and allows of the determination of the forces from observed small deformations. The results of experiments with clay are discussed in this connection. T. H. P.

4312. Kinematographic Analysis of Swelling in the Dark Field by Means of the Micromanipulator. Part I. K. Hess and B. Rabinowitsch. *Kolloid Zeits.* 64. *pp.* 257–268, *Sept.*, 1933.—This paper investigates the mechanism of swelling for cellulose fibres, wool fibres, natural silk, starch grains, and gelatin materials. The experiments show that the process of swelling is very complex and may be traced to separate minor operations, four of which have now been investigated, *viz.*, (1) Liquid penetration through the membrane; (2) Formation of a chemical compound between the substance and the entering liquid; (3) Solution of compound

(2) within the fibre; (4) Currents of outer liquid. These minor processes appear to cause the swelling to occur in two main stages, *viz.*, the formation of the compound followed by the typical swelling phenomena. Numerous photographs are included. H. H. Ho.

4313. Theory of Liesegang's Precipitates. H. Bauer. *Kolloid Zeits.* 64. *pp.* 181–184, *Aug.*, 1933.—The theory of the formation of Liesegang's rhythmic precipitation observed when silver nitrate diffuses into gelatin containing potassium dichromate, advanced by Morse and Pierce [see Abstract 663 (1904)], is insufficient to determine the distances and time-intervals between the layers of precipitate. The authors now assume that, after the metastable product H is reached, complete precipitation occurs, the solubility product being vanishingly small compared with H. Equations are derived which indicate that the successive spaces and time-intervals form increasing geometrical series, and are in good agreement with the extensive experimental data of Morse and Pierce. T. H. P.

4314. Surface Films of Cellulose Derivatives on Water and Dyestuff Solutions. Part II. J. B. Harding and N. K. Adam. *Faraday Soc., Trans.* 29. *pp.* 837–844, *Aug.*, 1933.—The paper continues previous work [see Abstract 1269 (1933)] on monomolecular films of cellulose derivatives on aqueous solutions. In the present work measurements of the "surface potential," *i.e.*, the change of contact potential between the solution and air caused by the presence of a surface film, are recorded. The results on films of methyl, benzyl and acetyl cellulose on aqueous solutions confirm the conclusions derived from previous measurements of surface pressure, namely that the hexose rings probably lie flat at low compressions, but are slightly tilted on compressing the films. The vibration of the chains of methyl cellulose, presumed to exist from the large areas occupied under low compressions, appear sufficient to cover areas up to 140 sq. Å per hexose group with a homogeneous film. There is evidence of small gaps in the film at larger areas. A lowering of surface potential is produced by the adsorption of picric acid in solution on to the cellulose films. S. G. B.

4315. Deformation Mechanism of Fibrous Materials. O. Kratky. *Kolloid Zeits.* 64. *pp.* 213–222, *Aug.*, 1933.—The characteristic difference between many high molecular materials and other organic substances is their ability to form plastic films. In the present and subsequent papers of this series the deformation of such films and the phenomena allied thereto are utilised for investigation of the micellar structure of fibres. In the present paper an ideal model is suggested for a strongly swollen cellulose film, which is essentially a structure consisting of elongated rods or micelles which slip upon one another with an amorphous medium in between them which acts as the swelling agent. From statistics the length of the micelles is calculated for simple stretching along their length, and the effects in two directions at right angles, *i.e.*, along the length and across the fibril, are deduced. The space distribution is statistically in agreement with the Debye-Scherrer findings and is investigated by actual photographs. From the statistics available the relative values of the birefringence are calculated and their values traced with increasing extension. The limits of thickness of the micelles and the possible errors in the method used are reviewed. S. G. B.

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4316. Properties of Gelatin in the Electric Field. Suzanne Veil. *J. de Physique et le Radium*, 4. *pp.* 362–367, *July*, 1933.—The gelatin was spread in a thin layer on a sheet of glass, the field being produced either between two parallel strips of metal foil on the glass, or between an outer annulus of foil and a central wire. In addition to mechanical deformations, the current carried by the gelatin has been observed. The initial current is not proportional to the potential difference, but increases less rapidly. At any given applied voltage the current falls with time to an almost vanishing value. When the gelatin is impregnated with a colloidal solution, bands or striae appear, which coincide with zones where the mechanical deformation changes its character. The hydrogen-ion concentration also changes discontinuously with position, from a strong acidity at the anode to a strongly basic value at the kathode. J. H. A.

See also Abstract 4464.

CRYSTAL STRUCTURE AND PROPERTIES.

4317. Non-Crystallographic Point-Groups. W. Nowacki. *Zeits. f. Krist.* 86. *pp.* 19–31, *Aug.*, 1933.—Tables, arranged as follows: I (A) Discontinuous point-groups, I (B) Continuous point-groups, II Geometrical Forms (I and I_n), III Point-complexes. F. I. G. R.

4318. Stereochemistry of Crystalline Compounds. Part X. Molecular and Crystalline Configurations. P. Niggli and W. Nowacki. *Zeits. f. Krist.* 86. *pp.* 65–99, *Aug.*, 1933.—A pseudo-geometrical approach to the subject in terms of valence, coordination and linkage. In an addendum, detailed reference is made to (a) Influence of coordination number upon binary compounds; (b) Pyro- and poly-salt formation; and (c) Oxy-radicals of type XO_n. [For Part IX see Abstract 4070 (1932).] F. I. G. R.

4319. Stereochemistry of Crystalline Compounds. Part XI. Formulæ of Crystalline Compounds, especially Silicates. P. Niggli. *Zeits. f. Krist.* 86. *pp.* 121–144, *Aug.*, 1933.—A formal discussion of genetic, full (or partial) constitutional formulæ, illustrated by reference to various types of silicates. F. I. G. R.

4320. Interatomic Distances in Crystals of the Alkali Halides. M. L. Huggins and J. E. Mayer. *J. Chem. Phys.* 1. *pp.* 643–646, *Sept.*, 1933.—The constants of the empirical repulsion potential assumed by Born and Mayer between two ions, which may be termed the ionic "radii," are calculated for the alkali and halide ions from the lattice constants of the alkali halides. By using 9 such radii the 20 lattice constants can be recalculated nearly within the probable experimental error of their determination. The good agreement is regarded as support for the asumptions involved in the calculations. [See also Abstract 2717 (1932).] AUTHORS.

4321. General Formula for the Lattice-Energy of Crystals of Arbitrary Structure. A. Kapustinsky. *Zeits. f. phys. Chem.* 22. *Abt. B.* 4. *pp.* 257–260, *Aug.*, 1933.—This contains a generalisation of the Madelung number, making thus an energy expression capable of extended application to lattice types. For a change of coordination 8 → 6, the decrease in Madelung's number amounts to 0·012, for 6 → 4 to 0·06 and for 8/4 → 6/3 to 0·04. F. I. G. R.

4322. Crystal Lattice Energies and the Born-Haber Cycle. A. Kapustinsky and B. Weselowsky. *Zeits. f. phys. Chem.* 22. *Abt.B.* 4. *pp.* 261–266, *Aug.*, 1933.—A formula is proposed containing the sum of the products of the valencies, the ionic radii and a numerical factor. This has been tested on about 100 compounds (fluorides, chlorides, bromides, iodides, oxides, sulphides), and found to give satisfactory agreement with observed values. F. I. G. R.

4323. Lattice Energies of Cuprous Halides. J. E. Mayer and R. B. Levy. *J. Chem. Phys.* 1. *pp.* 647–648, *Sept.*, 1933.—Following exactly the method employed in the case of the silver halides [see Abstract 2694 (1933)] the lattice energies of the cuprous halides have been calculated. The exponential constant in the empirical repulsion equation expressing the positive repulsive potential between the ions is found to be almost the same as that for the silver halides. The energies of the salts indicate that, particularly for the iodide there is not purely ionic binding. The lattice energies are calculated to be, for CuCl 216 kcal., CuBr, 208 kcal., CuI 199 kcal. The "experimental" values are, CuCl 221·9 kcal. CuBr 216·0 kcal. and CuI 213·4 kcal. AUTHORS.

4324. Liquid Metal-Crystals. Part I. E. Donat and O. Stierstadt. *Ann. d. Physik*, 17. 8. *pp.* 897–914, *Aug.*, 1933.—A method of growing and inoculating metal crystals is described: it rests upon the fact that the crystal is entirely stationary and never in contact with external disturbances. For bismuth, the same crystallographic orientation is retained after melting and freezing as the substance had in the first instance. A number of graphs (also for bismuth) indicate the thermal properties in various vectorial directions. F. I. G. R.

4325. X-Ray Analysis of Zirconium Tungstide ZrW_2. A. Claassen and W. G. Burgers. *Zeits. f. Krist.* 86. *pp.* 100–105, *Aug.*, 1933.—Structure cubic face-centered; the unit cell (containing 8 molecules) has an edge-length of 7·61 Å, and the calculated density is 13·78. F. I. G. R.

4326. Crystal Structure of Anhydrous Magnesium Iodide and Calcium Iodide. H. Blum. *Zeits. f. phys. Chem.* 22. *Abt.B.* 2. *pp.* 298–304, *Aug.*, 1933.—The powder method has been employed for the X-ray investigation of the iodides of magnesium and calcium which are optically found to be uniaxially negative, hexagonal, and isomorphous with cadmium iodide (C 6-Type). The lattice constants are: MgI_2: $a_o = 4 \cdot 14 \pm 0 \cdot 02$ Å, $c_o = 6 \cdot 88 \pm 0 \cdot 03$ Å, $c/a = 1 \cdot 66$. Density (Rontg.) $= 4 \cdot 48$. CaI_2: $a_o = 4 \cdot 48 \pm 0 \cdot 02$ Å, $c_o = 6 \cdot 96 \pm 0 \cdot 03$ Å, $c/a = 1 \cdot 55$. Density (Rontg.) $= 4 \cdot 01$. H. H. Ho.

4327. Crystal Structure of the Nitrides and Phosphides of Bivalent Metals. M. v. Stackelberg and R. Paulus. *Zeits. f. phys. Chem.* 22. *Abt.B.* 4. *pp.* 305–322, *Aug.*, 1933.—X-ray investigation of MgP_3 crystals reveals a cubic structure with 16 mols. to the unit cell. The space-group is T^7_h and the arrangement of the atoms corresponds with that of the cubic oxides M_2O_3 (Pauling). The phosphorus atoms form a somewhat deformed lattice of closest spherical packing and the magnesium atoms occupy three-fourths of the tetrahedra gaps of the phosphorus-atom lattice. The lattice may hence be described as an Na_2O (or CaF_2) lattice, in which one-fourth of the places of the metal atoms of the lattice are unoccupied, this conditioning some displacement of the atoms. These displacements are shown by the X-ray results and their direction and amount may be ascertained from models. Powder photographs of Be_3P_2, Be_3N_2, Mg_3N_2 and α–Ca_3N_2 indicate for these the Mg_3P_2 structure. With Ca_3N_2 a further modification, which is non-cubic, is found, and the structures of the nitrides of Sr and Ba and of the phosphides of Ca, Sr and Ba are also not cubic. Zn_3P_2, Cd_3P_2, and Zn_3As_2, which are metallic in character, form cubic crystals with 16 formula-weights in the unit cell, but the lattice is not that of Mg_3P_2. T. H. P.

4328. Crystal Structure of Zinc Hydroxide. R. B. Corey and R. W. G. Wyckoff. *Zeits. f. Krist.* 86. *pp.* 8–18, *Aug.*, 1933. *In English.*—Zinc hydroxide, crystallised from concentrated aqueous ammonia, is orthorhombic with *a* 5·16, *b* 8·53, *c* 4·92 Å, and 4 molecules in the unit cell, space group V^4. Each zinc atom is surrounded by four hydroxyl groups forming distorted tetrahedra, which are joined into zigzag chains in the direction of the *z*-axis. In a tetrahedron the distance Zn–O = 1·95 Å, and OH–OH is > 3 Å, but between adjacent tetrahedra OH–OH = 2·83 Å.
C. A. S.

4329. Crystallography and Space-Group of Carbonato Tetra-amine, Cobalti-Sulphate $\left[\begin{matrix}CO_3\\ Co(NH_3)_4\end{matrix}\right]_2 SO_4 . 3H_2O$. L. W. Strock. *Zeits. f. Krist.* 86. *pp.* 42–52, *Aug.*, 1933. *In English.*—The substance is monoclinic hemihedral, with $a : b : c = 1·1132 : 1 : 0·7030$, $\beta = 98° 39'$. with three cleavages parallel to (100), (010), (102), respectively. Optical character, strongly negative, bi-refringence high, optical axial plane parallel to (100). Refractive indices, $\alpha = 1·5973$, $\beta = 1·6210$, $\gamma = 1·6221$. Cell, 11·80 × 10·60 × 7·42 Å (containing two molecules) with a density of 1·8816. All types of reflection (*hol*), (*hko*) except (*ouo*) present, which, if point-group is C_s, indicates space-group C_s^1. F. I. G. R.

4330. Crystal Lattice and Calculated Refractive Indices of Sodium Hydrogen Carbonate. W. H. Zachariasen. *J. Chem. Phys.* 1. *pp.* 634–642, *Sept.*, 1933.—Sodium hydrogen carbonate is monoclinic with *a* 7·51, *b* 9·70, *c* 3·53 Å, β 93°19′, and 4 molecules in the unit cell, space group C_{2h}^5 ($P2_1/n$). Each Na atom is surrounded by 6 O, forming a distorted octahedron, Na–O = 2·37 to 2·57 Å; each H is linked to two O, H–O = 1·275 Å. Calculated by Bragg's method n_α, n_β, n_γ and $2V$ are respectively 1·393, 1·480, 1·583 and 92° compared with 1·380, 1·500, 1·586, and 110° observed. C. A. S.

4331. Fine Structure of Trinitrobenzene Derivatives. E. Hertel and G. H. Römer. *Zeits. f. phys. Chem.* 22. *Abt.B.* 4. *pp.* 267–279, *Aug.*, 1933.—The fine structures of a number of derivatives of *s*-trinitrobenzene have been investigated to ascertain the influence of substituents on the crystal structure. Owing to the size and shape of the trinitrobenzene molecule and the strong residual affinity of the nitro groups, it was to be expected that analogous substituents would exert no fundamental determining influence on the crystal structure. The results show, however, that the crystal structure is definitely determined by the substituents. The structures of the derivatives containing Cl, Br, I, OH, NH_2, NO_2, CH_3, OCH_3 and OC_2H_5 exhibit not the slightest analogy, each substance developing an individual structure principle. The densities exhibit certain regularities. In correspondence with the increasing weight of the substituent, the density increases in the order chloro-, bromo-, iodo-compound.

The density of trinitrobenzene is relatively high in comparison with those of its halogenated derivatives, this being attributable to the fact that the hydrogen atom requires a smaller space than the halogen atoms. In the series picric acid, trinitroanisol, trinitrophenetol, the density falls, the substituents becoming increasingly voluminous ; the same is the case with the series picric acid, trinitroaniline, trinitrotoluene. That the density of tetranitrobenzene is lower than that of trinitraniline is explained by the greater space required by the NO_2-groups than by the NH_2-groups. T. H. P.

4332. Crystal Structure of a New Type of Molecular Compound. E. Hertel and G. H. Römer. *Zeits. f. phys. Chem.* 22. *Abt. B.* 4. *pp.* 280–282, *Aug.*, 1933.—The crystal structure of the molecular compound of trinitrochlorobenzene with trinitrotoluene is perfectly analogous to that of trinitrotoluene. Rotation diagrams and Weissenberg films are completely superposable, and the intensities agree. Hence, in the lattice of trinitrotoluene every second molecule can be replaced by one of trinitrochlorobenzene without altering the crystal lattice. The system trinitrochlorobenzene-trinitrotoluene does not, however, form mixed crystals. The two phases trinitrochlorobenzene-trinitrotoluene and trinitrotoluene form a eutectic. T. H. P.

4333. Crystal Structure of Durene. J. M. Robertson. *Roy. Soc., Proc.* 141. *pp.* 594–602, *Sept.* 1, 1933.—Durene is monoclinic with a 11·57, b 5·77, c 7·03 Å, β 113·3°, and 2 molecules in the unit cell, space-group C_{2h}^5 ($P2_1/a$). The molecules are disc-like, the planes of molecules in adjacent rows being almost ⊥ to each other, and only 7° from ⊥ to the (001) plane ; the least distance between atoms in adjacent molecules is 3·7 Å. The structure closely resembles that of anthracene. C. A. S.

4334. Crystals of the Hydrated Chlorides, Bromides, Iodides of *d*- and *l*-Ephedrin and of *d*- and *l*-Pseudo-Ephedrin. B. Gossner and H. Neff. *Zeits. f. Krist.* 86. *pp.* 32–41, *Aug.*, 1933.—(1) *d*–$C_{10}H_{15}ON$. HCl.—Rhombic disphenoidal, with ratio $a:b:c=3\cdot934:1:1\cdot066$. Space-group V^4. Cell, 25·49 × 6·48 × 6·91Å. (2) *d*–$C_{10}H_{15}ON$. HBr.—Rhombic disphenoidal, with ratio $a:b:c=3\cdot602:1:0\cdot993$. Space-group V^4. Cell, 24·68 × 6·93 × 6·78Å. (3) *d*–$C_{10}H_{15}ON$. HI.—Rhombic disphenoidal, with ratio $a:b:c=1\cdot659:1:2\cdot276$. Space-group V^4. Cell, 11·39 × 6·83 × 15·62Å. (4) *l*–$C_{10}H_{15}ON$. HCl.—Monoclinic sphenoidal, with ratio $a:b:c=2\cdot066:1:1\cdot192$, $\beta=102°, 6'$. Space-group C_2^2. Cell, 12·64 × 6·15 × 7·34Å. (5) *l*–$C_{10}H_{15}ON$. HBr.—Monoclinic sphenoidal, with ratio $a:b:c=2\cdot0494:1:1\cdot2109$, $\beta=100°, 48'$. Space-group C_2^2. Cell, 12·74 × 6·20 × 7·62Å. (6) *l*–$C_{10}H_{15}ON$. HI.—Rhombic disphenoidal, with ratio $a:b:c=3\cdot4917:1:2\cdot5734$. Space-group V^3. Cell, 25·66 × 7·33 × 19·14Å. F. I. G. R.

4335. Liquid Crystals and Anisotropic Melts. *Faraday Soc., Trans.* 29. *pp.* 881–1085, *Sept.*, 1933.—A general survey of the subject comprising 23 papers, together with a general discussion on them by various contributors :—

"Theory of Liquid Crystals," by **C. W. Oseen** (*pp.* 883–899). An introductory paper dealing with the following points : (1) Forces giving rise to liquid crystals, (2) Structural singularities in nematic substances,

(3) Iridescent structures in cholesterine-nematic substances, (4) Motion of aeolotropic liquids, (5) Forms.

"System of Mixed Dimensions," by **D. Vorländer** (*pp.* 899–902). By "mixed dimensions" the author understands complexes in which plane areas are combined with lines in which, in special cases, the linear nature is very marked. The predominance of one particular dimension is of great consequence for the molecular nature of liquid crystals.

"Supra-Crystallinity of *p*-Azoxybenzoic Acid," by **D. Vorländer** (*pp.* 902–906). The highest degree of crystallinity is that in which, when breakdown occurs, it is the molecules which are disrupted rather than the crystal structure: thus the binding between molecules is stronger than the intra-molecular forces. Details follow for a number of azoxy-compounds.

"Liquo-Crystalline Resins and Lacquers," by **D. Vorländer** (*pp.* 907–910). Advanced states of molecular bifurcation lead to stationary super-cooled resins and lacquers: keeping one dimension predominating gives resins and lacquers stable at room temperatures.

"Cyclo-Pentanone and Cyclo-Hexanone," by **D. Vorländer** (*pp.* 910–912). Values of the bi-refringence show that the directional stability of movement is more than twice as great in the former compound as in the latter.

"Polymorphism of Liquid Crystals: A Demonstration," by **D. Vorländer** (*pp.* 913–914). X-ray work has usually indicated the existence of only two types of liquid crystals, and that further varieties are impossible. The author shows the actual existence of substances with three and four liquid-crystalline phases.

"Simple Arrangement to Demonstrate Liquid Crystals," by **G. van Iterson, Jr.** (*pp.* 915–919). The general principle is that of the Lehmann crystallisation miscroscope. The preparation is warmed to a temperature slightly higher than that required for observations, and then cooled by a jet of air. Transformation temperatures can be maintained for an unlimited length of time. A practical advantage is that the microscope and heating system are never in actual contact, so that no damage to lenses is likely to occur. Polarising prisms can be used.

"Forces causing the Orientation of an Anisotropic Liquid," by **V. Fréedericksz** and **V. Zolina** (*pp.* 919–930). (1) Experiments with a magnetic field, using *p*-azoxiphenetol and anisaldazin, point to the probability that the orientation of the liquid is determined by the orientation of the molecules and swarms in contact with the glass, and also by the interaction between the molecules or swarms within the liquid. (2) The orientating action of the magnetic field depends upon the diamagnetic properties of the substance. (3) Kast's X-ray results may be explained as due to the motions of an anisotropic liquid. The present authors consider that the motion is caused by the electrical anisotropy of the liquid, together with the phenomenon of electrostriction. (4) Experiments upon the elastic deformation of an anisotropic liquid indicate a change of orientation by mechanical means. Under certain conditions, it seems likely that resonance occurs. Intense excitation produces a semblance of boiling.

"New Arguments for the Swarm Theory of Liquid Crystals," by **L. S. Ornstein** and **W. Kast** (*pp.* 931–944). In a swarm all the molecules are arranged in parallel; the number of molecules in a swarm is of the order 10^5. The swarms are anisotropic (optically, diamagnetically, dielectrically). In nematic swarms, the molecular anisotropies are added, in cybotactic swarms they are largely cancelled out.

"Effect of a Magnetic Field upon the Nematic State," by **H. Zocher** (*pp.* 945–957). The molecular orientation is taken to vary continuously from one position to another within the substance: Brownian motion and convection currents are responsible for this. The author's "distortion theory" is well suited for problems involving surface actions.

"Magnetic Properties of Mesomorphic Subtances: Analogies with Ferromagnetics," by **G. Föex** (*pp.* 958–972). Paper consists of four sections: (1) Nematic substances, (2) Smectic substances, (3) Crystallisation in a magnetic field, (4) Diamagnetism and molecular structure. A normal liquid corresponds to a paramagnetic substance, and a nematic liquid to a ferromagnetic one, a transition point (analogous to that of Curie) existing between the two. Saturation is much more difficult with smectics than with nematics, pointing to an arrangement in the former case on parallel surfaces (focal conic or planar structures).

"Inclinations of Molecules in some Crystalline-Fluid Substances," by **K. Herrmann** (*pp.* 972–976). Report of work upon the thallium salts of stearic and oleic acids. In the former compounds, the angle at which the molecules slope is found to be about 47° for the liquid crystal, and 37° for the solid. In the latter, the angles are 53° and 34° respectively. The evidence is fully discussed.

"Rotating Molecules and the Liquid-Crystalline State," by **T. Malkin** (*pp.* 977–982). It is suggested that the molecules in the liquid-crystalline state are rotating about their long axes: the α-form of the esters is thus typical.

"Alterations in the Nature of a Fluid from a Gaseous to a Liquid-Crystalline Condition as shown by X-rays," by **G. W. Stewart** (*pp.* 982–990). Much larger molecular groups are present in liquid crystals than in liquids, but the semi-orderly arrangement is nearly alike for both. Cybotactic groups are found in either condition; the liquid-crystalline state is thus presumably composed of "companies" of molecules or cybotactic groups.

"Arrangement of Chain-Molecules in Liquid *n*-Paraffins," by **A. Müller** (*pp.* 990–993). A number of points in Stewart's paper (see *supra*) are discussed. The diffraction ring in these chain compounds is due to the assembly of molecules; the average distance of nearest approach (near the melting-point) is between 4·5 and 5 Å.

"Anisotropic Melts; A Study in Change of State," by **F. I. G. Rawlins** (*pp.* 993–994). It is stressed that the liquid-crystalline condition is much more general than is usually supposed, and the process of sublimation is discussed.

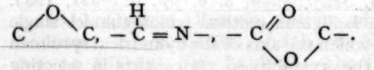
"Study of Crystalline Orientation by Electron Diffraction," by **J. J. Trillat** (*pp.* 995–1002). (1) Crystalline orientation of metals, (2) Structure and orientation of various thin layers, (3) Surface structure of liquids. In general, electron analysis gives refined information about exceedingly thin layers (only a few molecules thick). Further, only very small quantities of the substance under test are needed.

"Anomalous Viscosity in Mesomorphic Melts," by **Wo. Ostwald** (*pp.* 1002–1005). These melts exhibit strong structural viscosity, thus resembling gelatin or rubber sols. A close relationship exists between these systems.

"Viscosity of Liquid-Crystals," by **R. O. Herzog** and **H. Kudar** (*pp.* 1006–1008). The "experimental viscosity" η is given by the expression $\eta_{\mathrm{trans.}}\,(1 + \eta_{\mathrm{rot.}} / \eta_{\mathrm{trans.}})$, where the subscripts refer to the translational and rotational terms for a polyatomic liquid. The theory has been developed for dipole-free substances, but an investigation into its applicability to liquid crystals promises some degree of success. The values of η $(v - w)$ are smaller for the amorphous phase than for the anisotropic phase. Here v is the sp. vol. and w is the ratio of van der Waals' constant to the molecular weight.

"Lyotropic Mesomorphism," by **A. S. C. Lawrence** (*pp.* 1008–1015). Researches dealing with the following systems: (1) Crystalloidal mesoforms of soap, (*a*) anhydrous, (*b*) + water. (2) Anisotropic soap solutions —the true colloidal mesoform. (3) Structure in crystalloidal systems. The author discusses examples of anomalous flow, showing that the centre of the tube (maximum velocity) is also a region of anomalous flow, and indicating this flow is due to the structure of the solution. Near the walls, the travel is faster than that given by the parabolic relationship—elastic forces come into action. In general, it is stressed that the cases dealt with are of importance for their indication of structure in liquids.

"Paracrystallinity," by **F. Rinne** (*pp.* 1016–1032). A detailed discussion of the widespread occurrence of liquid crystals, and of their importance in biological problems, considered under the following heads: (1) Method of Formation, (2) Miscibility, (3) Inclusion of Natural Organic Objects in the Paracrystalline Group, (4) Notes on Nomenclature.

"Crystalline Phases of some Substances studied as Liquid Crystals," by **J. D. Bernal** and **D. Crowfoot** (*pp.* 1032–1049). In connection with X-ray analysis, the presence and significance of "smear lines" are discussed. A simple hot-wire heating device is described. From the examples studied, and in virtue of the results of other workers, it appears that liquid crystals seem to demand the following conditions for their formation: (1) The molecules must be geometrically anisotropic, either rod-shaped, flat, or lath-shaped. (2) Not more than one group capable of providing intense electric fields must be present in the molecule. (3) Molecules should contain such moderately active groups as C — Cl,  $\mathrm{C{-}O{-}C}$, $-\overset{\mathrm{H}}{\mathrm{C}}=\mathrm{N}-$, $-\mathrm{C}(=\mathrm{O}){-}\mathrm{O}{-}\mathrm{C}-$. (4) A larger structure (500–5000 molecules) appears fundamental for cholesteric types. Such compounds are optically negative: their optical activity, however, is probably irrelevant from a structural standpoint.

"Pseudo-Crystalline Structure of Water," by **R. H. Fowler** and **J. D. Bernal** (*pp.* 1049–1056). The two facts upon which the theory is based are that water is not an ideal close-packed liquid, and that the water molecule is asymmetrical. The following continuous scheme is deduced: Water I, "Tridymite-like" (light, viscous); Water II, "Quartz-like" (heavy, semi-viscous); Water III, "Liquid-ammonia-like" (light, non-viscous). No difference of molecule is present, but different arrangements of the same molecule exist in small regions of volume [see also Abstract 3951 (1933)].

[For further papers on Liquid Crystals see Abstracts 2952–2961 (1931).] F. I. G. R.

4336. Adsorption, Oriented Overgrowth and Mixed Crystal Formation. C. W. Bunn. *Roy. Soc., Proc.* 141. *pp.* 567–593, *Sept.* 1, 1933.—Defining as " adsorption bodies " crystals containing a small quantity of another substance adsorbed or included in the main constituent, their formation, as also that of mixed crystals, oriented overgrowths, and the phenomenon of adsorption are all due to varying degrees of agreement in the lattice structures of the constituents, the intermolecular distances along at least one plane of each differing by $\not>$ about 10 %, these similarly spaced planes being similarly oriented at the actual junction between the two substances. This explanation is illustrated by numerous examples : *e.g.*, NH_4Cl and $2NH_4Cl \cdot CuCl_2 \cdot 2H_2O$; NH_4Cl, NH_4Br, or NaCl and urea, etc. [See also Abstracts 1483 (1928), 1101, 1847 and 3562 (1932).] C. A. S.

4337. Perfection of Crystal Laminæ. W. N. Bond. *Phil. Mag.* 16. *pp.* 410–422, *Aug.*, 1933. *Supplement.*—Reference is made to experiments of Rayleigh [see Abstract 838 (1912)] and others on the perfection of the surfaces and uniformity of the effective thickness of cleavage laminæ of actual crystals. Laminæ of muscovite of about 1/100 mm. in thickness are tested by examining the banded spectrum of white light that has been reflected at the mica. (By using plane polarised light it is possible to make a biaxial crystal act as if it were isotropic.) Formulæ are derived for the resolution obtained at nearly grazing incidence, and the formulæ agree with experiment. The measurements of the thickness of the mica have an absolute error of about $\pm 2 \times 10^{-8}$ cm., together with an uncertainty common to them all of about 1/40%. It is shown that the mica lamina consists of several portions of different thickness, each of which is certainly uniform in effective thickness to 8×10^{-8} cm. and probably to 2×10^{-8} cm. or less. The stringency of the test is from 50 to 100 times that of Rayleigh's experiments. If the different thicknesses are all integral multiples of the length of the unit cell of muscovite, it is shown that the length of the unit cell must be less than $(23{\cdot}4 \pm 3{\cdot}1) \times 10^{-8}$ cm. : a length of unit cell of $(19{\cdot}84 \pm 0{\cdot}06) \times 10^{-8}$ cm. is indicated, but not uniquely determined. AUTHOR.

4338. Method of Producing Single Crystals. A. I. Froiman and P. A. Polibin. *Phys. Zeits. d. Sowjetunion,* 3. 6. *pp.* 627–631, 1933. *In German.*—A variation of the Bridgman method which enables single crystals of metals to be grown in which the axis of the cylindrical specimen has any required orientation to the crystal axes. It consists in selecting those centres of crystallisation for further growth which possess the desired inclination to the walls of the crystallisation tube. F. J. W.

4339. Mechanical Properties of Wetted Rock-Salt Crystals. N. Dawidenkow and M. Classen. *Phys. Zeits. d. Sowjetunion,* 4. 1. *pp.* 25–42, 1933. *In German.*—Measurement of the hardness of rock-salt by scratching in the sclerometer seems to be too insensitive to reveal even the influence of crystallographic orientation. This disadvantage is not shown by the damping method with the aid of the Kusnetzow pendulum, which shows no difference in hardness between the dry and the previously wetted rock-salt ; this observation is contrary to that of Schmid and Vaupel [see Abstract 3329 (1930)]. When the tests are carried out with partial protection against wetting, it is found that action of the water appears to be superficial and negative, consisting in the removal of the surface action harmful to the solidity and not in the formation of material solidified by the penetration. With the salt available to the authors, the solidification caused by wetting disappears entirely when the material is dried in alcohol. The elastic limit of the rock-salt in water, determined in polarised light, corresponds with that of the dry salt. T. H. P.

4340. High-Temperature X-Ray Camera for Precision Measurements. A. H. Jay. *Phys. Soc., Proc.* 45. *pp.* 635–642, *Sept.* 1, 1933. *Zeits. f. Krist.* 86. *pp.* 106–111, *Aug.*, 1933. *In English.*—A high-temperature X-ray camera has been designed for taking powder photographs which show well-resolved K_α doublets at high angles of reflections, enabling an accurate estimate of line position to be made. The temperature of the specimen was found in the following way. Photographs of silver, from which the lattice dimensions were calculated, were taken with varying heating currents. The coefficient of expansion of silver was used to convert lattice-spacing measurements to degrees centigrade. A curve relating the watts in the furnaces to the temperature of the specimens was thus obtained. A test of the reliability of the method was carried out by means of X-ray experiments on the expansion of quartz and the conclusion reached was that the assumption regarding the expansion of silver was valid. The temperature scale thus calculated was found to be correct to within 5° C. AUTHOR.

See also Abstracts 4348, 4349, 4487, 4562, 4565, 4577, 4644, 4645, 4646, 4665.

DENSITY.

See Abstract 4331.

DIFFUSION AND OSMOSIS.

4341. Diffusion Problems. P. Clausing. *Physica,* 13e. 7. *pp.* 225–230, 1933.—In the first place the mean time is calculated which it takes a molecule to traverse a tube of given length joining two recipients. This is then applied by a mathematical device (explained) to the calculation of the velocity of propagation of a disturbance along a tube open at one end, this disturbance consisting of the replacement at the open end of the tube of a given number of molecules of the gas by an equal number of molecules of another gas. A. D.

4342. Optical Determination of the Diffusion Constant of Sodium. L. A. Ginsel and L. S. Ornstein. *Zeits. f. Physik,* 84. 5–6. *pp.* 276–281, *July* 31, 1933.—The flame above a small borax bead is photographed through a filter absorbing all wave-lengths below 5600 Å, and the intensity distribution is determined from the blackening by comparison with intensity marks recorded on the plate by photographing a homogeneous sodium flame through a step wedge. Exposures are made at flame velocities of 415 and 625 cm. per sec. The diffusion constant D is calculated from the observed intensity distribution, the value obtained being $3\cdot24$ ($T = 2100°$ Abs.). The radius of the sodium atom, deduced from this value according to the kinetic theory, comes out to $2\cdot6 \times 10^{-8}$ cm. L. A. W.

4343. Diffusion of Helium through Crystalline Substances and the Molecular Flow through Rock Masses. W. D. Urry. *Am. Chem. Soc., J.* 55. *pp.* 3242–3249, *Aug.*, 1933.—Contrary to the results obtained for glass [see Abstract 49 (1933)] no passage of helium through various metals over a range of temperature and pressure could be detected.

Excited helium, however, passes through bismuth. The adsorption of helium on steel was found to be zero. The loss of helium from rocks cannot be compared to the loss from the usual radioactive minerals. From the measurement of rate of flow of gases through natural rock, a mathematical expression for the fineness of grain of the rock was deduced. The rate of flow of helium through a single quartz crystal was found to be zero. N. M. B.

4344. Empirical Equation for Calculating Osmotic Pressures. (Earl of) Berkeley. *Phil. Mag.* 16. *pp.* 298–310, *Aug.*, 1933.—The formula proposed is $Pws_2/A^{2/3}(e^{A^{1/3}}-1)=K$, a constant, where P is the osmotic pressure, w is the specific volume of the solution, and $A=c_2 s_2 M_1/c_1 s_1 M_2$, in which $c_2=1-c_1$ is the number of gm. of solute in 1 gm. of solution ; s_2 and s_1 are the changes in the volume of a practically infinite mass of solution when 1 gm. of solute or solvent, respectively, is withdrawn, and M_2 and M_1 are the molecular weights of solute and solvent. Data are given for calculating the constant at 0° and 30° for aqueous cane-sugar and other substances. The significance of s_1 and s_2 and a possible physical meaning of the quantities in the equation are discussed. The application of the formula to ionised aqueous solutions is examined for a number of salts with a view to throwing some light on the dissociation question, and approximate data are obtained. N. M. B.

See also Abstracts **4316**, **4633.**

ELASTICITY AND PLASTICITY.

4345. Flexural Centre and Centre of Twist of an Elastic Cylinder. W. J. Duncan, D. L. Ellis and C. Scruton. *Phil. Mag.* 16. *pp.* 201–235, *Aug.*, 1933.—The flexural centre of a cantilever beam is defined, and formulæ are quoted which give the position of the flexural centre of a cylinder whose section has an axis of symmetry. Next the centre of twist is defined, and a method is stated for its determination when the boundary conditions are strictly compatible with the St. Venant theory of torsion. In the second part experimental methods are described, and an account is given of tests on a long mild-steel cylinder of thin symmetrical aerofoil section and a mild-steel prism with section in the form of a slender isosceles triangle. In the first case, the flexural centre and the centre of twist were found to lie at the theoretical position of the flexural centre ; in the second, both centres lay near the base, the centre of twist being the nearer by about 0·03 of the chord. In an Appendix is given an approximate solution of the St. Venant torsion problem for an isosceles triangular prism. G. E. A.

4346. Shear Elasticity of Water Films. B. Derjaguin. *Zeits. f. Physik*, 84. 9–10. *pp.* 657–670, *Aug.* 12, 1933.—The lower end of a torsional pendulum is shaped to the segment of a sphere, and between its lowest part and a rigid floor is a thin layer of water. The effects produced by altering the thickness of the layer on the period and character of the torsional oscillations, affords a means of measuring the rigidity of the liquid film. For very small displacements, a film of pure water behaves as an elastic solid, with a definite rigidity (2 kg./mm². when the thinnest part of the film is 0·09 μ), and a definite yield point. For greater thicknesses the rigidity is smaller, disappearing for layers of greater thickness than 0·15 μ. The known, abnormally high value of the viscosity of water in very thin layers confirms this value. Addition of a very small quantity of impurity produces a considerable rise in both the rigidity and the yield value; from which it is inferred that the impurity is concentrated at the liquid-solid interface. J. P. A.

4347. Compressibility of Solutions. Part I. Apparent Molal Compressibility of Strong Electrolytes. F. T. Gucker, Jr. *Am. Chem. Soc., J.* 55. *pp.* 2709–2718, *July*, 1933.—The apparent molal compressibility, *K*, of a number of solutes, defined as the difference between the compressibility of a volume of solution containing one mole of solute and the compressibility of the solvent, is calculated from existing data. *K* is in general a linear function of the square root of the volume concentration from dilute solution to saturation (sulphuric acid appears to provide an exception); it is always negative and becomes less negative with increase of concentration and more negative with increase of the valencies of the solute ions. It appears to be an additive property of the ions at infinite dilution. H. F. G.

4348. Plasticity in Single Crystals. W. G. Burgers. *Phys. Zeits.* 34. *pp.* 623–624, *Aug.* 15, 1933.—In Schlechtweg's paper on this subject [see Abstract **3317** (1933)] the difference between theoretical rigidity and experimental plasticity in crystals is ascribed to singularities in the tension state of the test piece required, and it is considered that the existence of places of microscopic inhomogeneity is not necessary for the understanding of the above difference. Burgers considers that such macroscopic bending with sliding is not essential for the sliding process in a single crystal, but that the process is rather of a microscopic nature. **Schlechtweg** in remarks on the paper, referring to the essence of the sliding process regards it as rather immaterial whether it arises from a disturbance of the lattice or otherwise. It is noteworthy that the ideal crystal can slide plastically. J. J. S.

4349. Cohesion and Plasticity in Crystals. A. Smekal. *Phys. Zeits.* 34. *pp.* 633–639, *Aug.* 15, 1933.—The addition of a measured small quantity of impurity to pure synthetic crystals of NaCl has been shown to diminish the tensile strength at low temperatures. Since the complication of plasticity is least prominent at these temperatures, the tensile strength should be closely related to the cohesion. In the most refined crystal, however, there remains a small unknown quantity of impurity, and the measured strength must always be less than the theoretical, by an indefinite amount. From a survey of the chief experimental data, it is shown that a very large difference should be anticipated. The profound influence exerted by small inclusions upon the processes of both fracture and plastic flow, is fully considered, and the actual large difference between theoretical and experimental values for the strength is due almost exclusively to local faults or impurities. J. P. A.

4350. Relation between Strain and Photoelastic Effect in Phenolite. J. Kuno. *Phil. Mag.* 16. *pp.* 353–362, *Aug.*, 1933. *Supplement.*—The total effect produced by the phenolite in circularly polarised green light from a mercury lamp is expressed in terms of the two principal stresses at the point and of the time. The strain is expressed in a similar manner. The experiments show that (1) the stress is not the immediate cause of the phenomenon, (2) the strain seems to produce the photoelastic effect, and (3) Poisson's ratio is independent of the time effect. Phenolite is composed chiefly of phenol and formaldehyde. [See also Abstract 3105 (1932).] G. E. A.

4351. Simple Instrument for Measuring Plasticity and Recovery of Soft Materials. J. Hoekstra. *Physics,* 4. *pp.* 285–288, *Aug.,* 1933.—The material is compressed between two bars the upper of which is carried by one end of a lever arrangement the other end of which magnifies the compression in the ratio 50 : 1. The compression is by any required weight which is removable at will. The instrument is specially adapted to the measurement of the elasticity and recovery of rubber and similar substances. P. H. B.

4352. Graphical Representation of Two-Dimensional Stress Distributions. V. Tesar. *Frank. Inst., J.* 216. *pp.* 217–224, *Aug.,* 1933.—The author reviews former graphical methods used to give the direction and magnitude of stresses. For the former a system of isostatic lines or stress trajectories is mostly employed. For the latter the procedure is more complicated. A method is then given by which a complete portrayal of any stress distribution is obtained from two diagrams, one being the usual isostatic network and the other a system of curves representing the magnitudes of forces normal to the isostatics. The method is illustrated by its application to the case of a circular disc under diametrical compression. R. S. R.

See also Abstracts 4303, 4311, 4315, 4339, 4367, 4418, 4419, 4420.

GRAVITATION.

4353. Stresses in Gravitating Solid with Spherical Inclusion. G. Nishimura and T. Takayama. *Tokyo Univ. Research Inst., Bull.* 11. *pp.* 196–228, *June,* 1933. *In English.*—The distribution of stress in the interior of a gravitating semi-infinite elastic solid, in which is embedded a spherical inclusion of different density, is studied in the neighbourhood of the inclusion. It is assumed that the state of the gravitating solid is one of plane strain, consideration of the problem when the medium is subjected to plane stress being deferred to another occasion. The problem has importance in connection with the stress accumulation necessary for an earthquake, since the stresses are accumulated mainly in the vicinity of common boundaries of contiguous materials having different physical properties. A previous study, concerning the special case of a spherical cavity in a gravitating semi-infinite solid, has already been published [see Abstract 4158 (1932)]. Spherical coordinates are used and the equations of stress obtained in zonal harmonics. Tables and data are obtained for representative values 1/5, 5 and ∞ of the ratio of the Lamé constant μ of the inclusion to that of the solid. Graphs are plotted showing the azimuthal and radial variations of stress corresponding to these ratios, and the conclusions as to symmetry, and dependence on the relative rigidities of the included and surrounding media and on the depth of the inclusion, are derived and summarised. It is pointed out that the mathematical results obtained are not applicable to the case when the spherical inclusion has no rigidity. E. L. J.

4354. Stresses in Gravitating Solid with Cylindrical Inclusion. G. Nishimura and T. Takayama. *Tokyo Univ. Research Inst., Bull.* 11. *pp.* 229–253, *June,* 1933. *In English.*—In this paper the authors consider the problem of stress distribution in the interior of a gravitating semi-infinite solid in which a cylindrical mass is embedded, as compared with the spherical embedded mass [see preceding Abstract]. As before, the gravitating solid is assumed to be in a state of plane strain, and tables and graphs are given showing the variation of the stress with different values for the ratio of the rigidity constants of the inclusion and surrounding solid. The conclusions are summarised. E. L. J.

4355. Temporal Variation in Gravity. E. Kleinschmidt. *Ann. d. Physik*, 17. 6. *pp.* 725–728, *July*, 1933.—The author raises doubts as to some of the conclusions drawn from measurements made with a bifilar gravimeter by Tomaschek and Schaffernicht [see Abstract 1318 (1933)], particularly as regards the influence of the moon's motion upon the earth's crust. It is suggested that the estimate obtained of the deformation on this account is too high, and that the value assumed for δ—the ratio of the measured variation in gravity to the variation calculated on the assumption of a perfectly rigid earth—is nearer 0·8 than 0·55. The elastic inertia of the elinvar spring of the apparatus is suggested as a possible source of error. In a footnote the authors of the previous article undertake to show in a subsequent communication that the objections adduced above are not relevant to their particular method. E. L. J.

HYDRODYNAMICS AND AERODYNAMICS.

4356. Mechanics of Liquids and Gases. Part I. L. Schiller and A. Naumann. *Die Physik*, 1. 3. *pp.* 101–122, 1933.—Recent developments, principally since 1927, in the experimental investigation of the stream line and turbulent flow of liquids and gases are briefly reviewed. J. S. G. T.

4357. Boundary Condition for Turbulence in Pipes. G. D. Mattioli. *Accad. Lincei, Atti*, 17. *pp.* 932–934, *June* 2, 1933.—Extends the work [see Abstract 2752 (1933)] in which the viscosity was confined to the surface layer, to the problem of the interaction of this surface layer with the other regions of the turbulent liquid, and works out a solution of this problem. A. D.

4358. Laminar Spread of a Jet. H. Schlichting. *Zeits. f. angew. Math. u. Mechanik*, 13. *pp.* 260–263, *Aug.*, 1933.—The mixture of a fluid jet, with surrounding fluid, under conditions of laminar viscous forces, *i.e.*, absence of turbulence, is discussed mathematically. J. S. G. T.

4359. Instability of Liquid Jets. E. Tyler. *Phil. Mag.* 16. *pp.* 504–518, *Aug.*, 1933. *Supplement.*—The degree of instability of capillary jets is examined experimentally. Spark photographs produced under varying conditions are included, from which measurement of the size and spacing of the drops formed at the end of the jet enables a comparison with theory to be made. Methods suitable for determining the frequency of drop formation are described employing the use of (*a*) photoelectric cell, (*b*) flashing neon tube, and (*c*) stroboscope or rotoscope. A knowledge of such frequencies of resolution together with the corresponding diameter and speed of the jet permit a further comparison between theory and experiment. Such comparisons reveal satisfactory agreement. AUTHOR.

4360. Inertia Law of Small Spheres in Frictional Media. T. Sexl. *Phys. Zeits.* 34. *pp.* 605–608, *Aug.* 1, 1933.—The author criticises the paper on this subject by E. Wasser [see Abstract 2762 (1933)] as not having taken into consideration the work of Knudsen and others, and points out an error in one of Cunningham's deductions. In his reply **E. Wasser** states that his object was not to give an exhaustive account of the subject, but only to consider it from a single point of view. J. J. S.

See also Abstracts 4378, 4582.

KINETIC THEORY OF MATTER.

4361. Calculation of Mean Brownian Area. A. Kolmogoroff and M. Leontowitsch. *Phys. Zeits. d. Sowjetunion,* 4. 1. *pp.* 1–13, 1933. *In German.*—The problem solved is the calculation of the probable area on any plane, covered in unit time by the projection of the path of a finite particle undergoing Brownian motion. J. H. A.

See also Abstracts 4342, 4360, 4378.

LENGTH (STANDARDS, MEASUREMENTS, APPARATUS).

See Abstract 4466.

MASS (STANDARDS, MEASUREMENTS, APPARATUS).

4362. Precision Weights. J. J. Manley. *Phil. Mag.* 16. *pp.* 489–504, *Aug.*, 1933. *Supplement.*—An investigation of the origin of the films formed upon stored weights, their influence on the affected masses and of means for maintaining the desired constancy in the masses of precision weights. It was found that free acid in the glue used to secure the felt linings of the boxes in which the weights were stored was responsible for the development of the films. The mass removed on carefully wiping a gilded brass weight which had been stored in an ordinary felt-lined box for one year amounted to 0·011 mg./cm². It was found best to support the weights on polished supports of the same metal as the weights themselves and in cells of materials which do not give off vapours. By this means the mass of the film removed on wiping gilded brass weights after 11 weeks storage was reduced to about 0·0001 mg./cm². Some remarks on some other results of wiping a weight prior to using it are appended. P. H. B.

MATHEMATICAL METHODS. THEORY OF MEASUREMENTS. UNITS AND DIMENSIONS.

4363. Space-Time Scale as a Quantum Coordinate System. W. Bender. *Frank. Inst., J.* 216. *pp.* 157–182, *Aug.*, 1933.—Further developments of the author's theories with regard to the fundamental methods of measurements in physics are given [see Abstract 82 (1933)]. G. C. McV.

See also Abstract 4352.

MECHANICS, CLASSICAL.

4364. Fundamental Formula of the Kinematics of a Rigid Body. Luisa Pelosi. *Accad. Lincei, Atti,* 17. *pp.* 940–944, *June* 2, 1933.—A new proof of the fundamental formula which gives the velocities of the points of a rigid body in motion. A. J. McC.

4365. Homogeneous Variables in Classical Dynamics. P. A. M. Dirac. *Cambridge Phil. Soc., Proc.* 29. *pp.* 389–401, *July* 30, 1933.—The well-known methods of classical dynamics, based on the use of a Lagrangian or Hamiltonian function, are adequate for the treatment of nearly all dynamical systems met with in practice. There are, however,

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a few exceptional cases to which the ordinary methods are not immediately applicable. For example, the ordinary Hamiltonian method cannot be used when the momenta p_r, defined in terms of the Lagrangian function L by the usual formulæ $p_r = \delta L/\delta \dot{q}_r$, are not independent functions of the velocities. A practical case of this kind is provided by the electromagnetic field, considered as a dynamical system with an infinite number of degrees of freedom, since the momentum conjugate to the scalar potential at any point vanishes identically. Again, for the very simple example of the relativistic motion of a particle of zero rest-mass in field-free space, the Lagrangian function vanishes and the usual Lagrangian method is not applicable. One can avoid having irregularities in the theory due to such exceptional cases by a re-formulation of the scheme of equations with the use of homogeneous variables. No essential change of principle is involved in the re-formulation. The homogeneity condition may be applied either to the velocities or to the momenta. The main change when the velocities are made homogeneous is that the Hamiltonian function is replaced by a Hamiltonian equation, and the main change when the momenta are made homogeneous is that the Lagrangian function is replaced by a Lagrangian equation. In either case an extra coordinate must be introduced, which may be treated on the same footing as the previously existing ones. With combined homogeneous velocities and momenta there must be two such extra coordinates. A mathematical development is given. Some examples are also worked out. A. D.

4366. Hamiltonian Principle in Point Mechanics. Fundamentals of the Super-Quantification Method. J. L. Destouches. *Comptes Rendus*, 196. *pp*. 1955–1957, *June* 26, 1933.—Purely mathematical. A theorem is enunciated according to which the movement of a point M defined by $\overline{OM} = \psi(t)$ between times t_0 and t_1 is characterised by the fact that the integral $\int_{t_0}^{t_1} Ldt$ is stationary. H. F. G.

4367. Measurement of Mechanical Resistances by Rotatory Motions. E. Paolini. *Zeits. f. techn. Physik*, 14. 8. *pp*. 332–335, 1933.—A simple apparatus is described for the measurement of mechanical resistances which consists of two rigid revolving systems, one of which measures the moment of rotation imposed and the other the instantaneous angle produced. With this installation several liquid resistances have been determined. In addition, an electrical method is described whereby mechanical resistances of every kind may be produced. Applications are discussed. H. H. Ho.

See also Abstracts 4361, 4374.

MECHANICS, QUANTUM.

4368. Generalisation Possibilities of the Formalisms of Quantum Mechanics. P. Jordan. *Göttingen Nachrichten, Math. Phys. Klasse*, 2. *pp*. 209–217, 1933.—The difficulties of the Dirac theory of electrons, as well as of quantum electrodynamics, give rise to the opinion that not only the models but also the formalisms of the quantum theory require fundamental deepening, and this viewpoint is strengthened by the current *ad hoc* treatment of nuclear physics. It is now found that the hypothesis of the association law for the multiplication of measurable quantities involves an assumption whose necessity is doubtful. The present paper contains an investigation of this problem, and shows that the possibility of a generalisation of the current theory without renunciation of the fundamental assumption of reproducible measurements depends on the mathematical existence of hyper-complex systems of quantities with definite characteristics. Certain mathematical data are derived to enable a decision as to the existence of such systems. H. H. Ho.

4369. Geometry of Spinors. G. Mie. *Ann. d. Physik*, 17. 5. *pp.* 465–500, *July*, 1933.—A purely mathematical paper on the theory of Dirac's ψ-functions (spinors) treated from the geometrical point of view. The spinors are considered as having eight components, formed by four quantities together with their conjugate complexes. The space dealt with is Euclidean. G. C. Mc.V.

4370. Maxwell's and Dirac's Equations. K. Nikolsky. *Phys. Zeits. d. Sowjetunion*, 4. 1. *pp.* 76–79, 1933. *In English.*—Maxwell's equations are given in a form which makes it possible to treat the principle of superposition and interaction of the charges in the classical theory. H. L. B.

4371. Dirac's and Schrödinger's Equations. T. Levi-Civita. *Preuss. Akad. Wiss. Berlin, Ber.* 5. *pp.* 240–250, 1933.—From Dirac's matrix equations in the general gravitional field a modified form of Schrödinger's four equations of the second order is obtained. The justification of these new generalised equations lies in the fact that they become identical with the appropriate Dirac's matrix equations in the particular cases of electrons in magnetic or electric fields without gravitation. G. G. S.

4372. Wave Equation of the Electron in the General Relativity Theory. L. Infeld and B. L. van der Waerden. *Preuss. Akad. Wiss. Berlin, Ber.* 9. *pp.* 380–401, 1933.—The authors consider the procedure of Schrödinger in generalising the Dirac four-rowed matrices to be unnecessarily complicated [see Abstract 4119 (1932)], and they put forward a simpler method. Two-rowed matrices are introduced, their formation being governed by the well-known rules of the tensor-calculus. Two-component spin vectors are transformed to be independent of the world-vector. Dirac's equations can immediately be written down by carrying out a covariant differentiation for the spin-quantities. An arbitrary world-vector appears in the expression for the covariant differentiation which is identified with the electromagnetic potential. **Errata,** 13. *p.* 474, 1933. G. G. S.

4373. Interpretation of Dirac's Wave Functions. Probability and Determinism. F. Prunier. *R.G.E.* 34. *pp.* 133–135, *Aug.* 5, 1933.—Develops an interpretation of Dirac's wave theory in which the components of the Dirac wave function are identified at each point of space time, with four components of the electric and magnetic vectors at that point provided the axes of reference are suitably chosen. The close relationship indicated between the wave functions and the electromagnetic field suggests to the author that the probability interpretation of quantum mechanics, as expounded by Born, may not be inescapable. W. S. S.

4374. Basic Conceptions of Wave Mechanics. L. Flamm. *E.u.M.* 51. *pp.* 409–413, *July* 23, 1933.—A short treatise on the development of wave-mechanical ideas. Stresses the connection between Schrödinger's equation and the Hamilton-Jacobi equation and the fact that de Broglie's wave-mechanics is based on the analogy between the mechanical principle of least action and the optical principle of least time. G. G. S.

4375. Extension to Wave-Mechanical Theory. R. Zaycoff. *Zeits. f. Physik,* 84. 3–4. *pp.* 264–267, *July* 26, 1933.—In an almost entirely mathematical paper the author discusses his eight-component wave-mechanics [see Abstract 3932 (1933)] and deduces a covariant form for the wave equation. J. E. R. C.

See also Abstracts 4385, 4407, 4536, 4589, 4590, 4627, 4664.

RELATIVITY AND ETHER.

4376. New Form of Lorentz Formulæ. J. le Roux. *Comptes Rendus,* 197. *pp.* 394–397, *July* 31, 1933.—As is known, the restricted theory of relativity is based on an interpretation of the Lorentz formulæ. This interpretation itself involves certain hypotheses, of which Poincaré repeatedly demonstrated the singularity. It is possible, however, by the addition of another variable, to give the Lorentz formulæ a new form, of which the interpretation is exempt from these hypotheses. The new variable is a time-datum common to both the systems of reference, and simply related to t and t^1. A. D.

4377. Expanding Universe and the Time Scale. W. de Sitter. *Roy. Astron. Soc., M. N.* 93. *pp.* 628–634, *June,* 1933.—Reasons are given for supposing that the actual universe did not start expanding from the Einstein state, but that it corresponds to a spherical universe whose radius has passed through a minimum value some 5×10^9 years ago. This event, however, is not to be regarded as the beginning of the universe, but merely as a moment when the galaxies were comparatively close together. The chance of collisions both between galaxies and between individual stars would then be much greater. It is to be expected, therefore, that the galaxies would have the appearance of having only rotated a few times and that the sun's planetary system should exhibit evidence of having been formed 10^9 years ago. G. C. McV.

See also Abstracts 4361, 4371, 4372.

SOLUTION.

See Abstracts 4347, 4595.

SURFACE TENSION AND COHESION.

4378. Hydrodynamics and the Kinetic Theory of Gases. Theory of Surface Tension. Y. Rocard. *Comptes Rendus,* 197. *pp.* 122–124, *July* 10, 1933.—The following expression is developed for the surface tension, H, of a fluid which is nonhomogeneous with regard to density :—

$$H = 7\cdot 32\,\sqrt{\lambda}\sigma\left(\frac{\rho_1 - \rho_2}{\rho_c}\right)\mathrm{P}_c\left(1 - \frac{1\cdot 03\,\mathrm{T}}{\mathrm{T}_c}\right),$$ where P_c, T_c and ρ_c are the critical pressure, temperature, and density, respectively, λ is a coefficient slightly greater than unity, σ the diameter of the molecules, and ρ_1 and ρ_2 the densities of the liquid and vapour, respectively ; λ depends on the law assumed to govern the forces between the molecules. For molecules of zero or very small dipole moment and of approximately spherical shape the equation conforms closely with observation. For elongated molecules

and strongly polar substances the deviations are of the order of 40%, since the equation does not take orientation into account. A law of corresponding states is enunciated, according to which $H/\sigma P_c$ is the same function of the reduced temperature for all substances for which the same type of intermolecular force is operative. H. F. G.

4379. Surface Tension of Liquids near the Critical Temperature. C. A. Winkler and O. Maass. *Canad. J. of Research*, 9. *pp.* 65–79, *July*, 1933.—The surface tensions of methyl ether and propylene were determined by the capillary rise method at temperatures closely approaching the critical temperature. The surface tension—temperature curves did not become asymptotic to the temperature axis at the critical temperature, thus indicating a discontinuity in properties at the critical point. Katayama's equation is shown to be more accurate than that of Ramsay and Shields. Sugden's equation is found to be valid. The Macleod constant for propylene but not methyl ether increased with rising temperature. Reasons are given for ascribing the increase with temperature of the parachors of substances having unsaturated linkages in their structure to increase of electronic interaction. Details are given of an adaptation to this work of the ring method of determining surface tension. P. H. B.

4380. Electrical Properties of Monomolecular Films on Liquids. H. G. Yamins and W. A. Zisman. *J. Chem. Phys.* 1. *pp.* 656–661, *Sept.*, 1933.—A new method of studying the electrical properties of monomolecular films floating upon a liquid has been described. Measurements on the potential jump dV, because of the presence of monomolecular films of oleic acid, palmitic acid, tricaprylin, and trimyristin on water have been made in order to furnish a comparison with the work of Guyot [see Abstract 971 (1925)]. Excellent agreement was found in all cases. In addition, Guyot's conclusion was verified that dV for fatty acids depends greatly upon the presence of a trace of sulphuric acid in the water while dV for substances like tricaprylin and trimyristin is but slightly affected by the presence of acid. AUTHORS.

4381. Electrophoretic Null-Point for Mercury in Aqueous Solutions. S. R. Craxford. *Phil. Mag.* 16. *pp.* 268–274, *Aug.*, 1933.—The potential of the electrophoretic null-point for a mercury drop in a series of solutions has been measured, the potential across the mercury-solution interphase being fixed by polarisation. This is found within the limits of experimental error to be the same potential as the electrolytic null-point given by the potential of the electrocapillary maximum in all cases, including those in which salt is strongly specifically adsorbed at the surface of the mercury drop. AUTHOR.

See also Abstracts 4314, 4346, 4349, 4359, 4579.

TIME (STANDARDS, MEASUREMENTS, APPARATUS).

4382. Schuler Pendulum. J. Weber. *Naturwiss.* 21. *pp.* 543–547, *July* 22, 1933.—An examination of the question of uniformity, or want of uniformity, of time-measurement by means of the rotation of the earth. Discussion of the various methods in use for comparative measurements. Preference given to the Schuler pendulum (which is described and studied) on account of its accuracy and of its inexpensive simplicity. A. D.

4383. Applying Electric Fields for Short Intervals of Time. D. N. Nasledov, L. M. Nemenov and N. M. Reinov. *Journ. Sci. Instruments*, 10. *pp.* 288–291, *Sept.*, 1933.—A mechanical switching device is described which will close an electric circuit for intervals of time of the order of 10^{-4} sec. A specially designed apparatus is fastened to the end of a wooden ring mounted on an electric motor shaft revolving at about 1500 r.p.m. A form of " tearing contact " is also described, and the method appears to work for potentials of several hundred volts. AUTHORS.

4384. Device for Accurately Timing Watches. G. P. Luckey. *Rev. Sci. Instruments*, 4. *pp.* 504–506, *Sept.*, 1933.—The balance wheel of the watch is observed by a stroboscopic method. It is illuminated once every fifth of a second by a flash of light reflected from a mirror placed at an angle of 45° on the shaft of a synchronous motor. A special source of alternating current whose frequency is controlled by a Reifler clock is used. The phase in which illumination takes place is initially adjusted so that successive views of the balance arm in its position of maximum velocity appear identical although the arm is moving alternately in opposite directions. As the balance arm and the illumination subsequently become out of phase a flicker develops. At the end of a definite period, usually 1 min., the phase at which illumination takes place is shifted by rotating the stator of the motor so that coincidence is again obtained. The rate of the watch is calculated from the rotation of the stator. A rate of 1/7200 sec. per minute is observable. P. H. B.

4385. Atom as a Space-Time Quantum System. G. Beck. *Helv. Phys. Acta*, 6. 5. *pp.* 309–314, 1933. *In German.*—Analogous to the chemical unit of mass (*i.e.*, that of the H-atom), units of time [see Abstract 426 (1929)] and length [see Abstract 2115 (1929)] have been suggested *viz.*, the chron ($4 \cdot 37 \times 10^{-24}$ sec.) and the odon ($1 \cdot 31 \times 10^{-13}$ cm.), where these units together with the proton and electron are to be regarded as intrinsic units in a 4-dimensional world. It is now shown that the ratio of the masses of the proton and electron may be derived from dimensional considerations, and also that the assumption of the fundamental orbit of the H-atom being a multiple of the fundamental unit of length (*i.e.*, that space is a quantum expression) is compatible with experience. H. H. Ho.

VACUA, HIGH.

4386. Improvement of Vacua by Electrical Discharges. W. v. Meyeren. *Zeits. f. Physik*, 84. 9–10. *pp.* 531–540, *Aug.* 12, 1933.—The " clean-up " of air and hydrogen is investigated in the pressure range 10^{-4}–10^{-6} mm. by means of a hot-kathode tube of special design. By increasing the electron density and their length of path in the gas by a combination of a ring anode and a magnetic field parallel to the axis of the discharge an enhanced ionisation effect was obtained and the pressure in an enclosed volume of two litres was reduced from 10^{-4} to 10^{-6} mm. in a few minutes. J. E. R. C.

VISCOSITY, FRICTION AND LUBRICATION.

4387. Viscosity of Fused Salts and the Andrade-Sheppard Formula for the Viscosity of Liquids. B. Prasad. *Phil. Mag.* 16. *pp.* 263–268, *Aug.*, 1933.—By examination of the results given by various authors for the viscosity of fused salts, it is found that the alkali nitrates and lead bromide obey the formula $\log \eta = \alpha + \beta/T$, where η is viscosity and T the absolute temperature. For lead chloride, the formula is $\log \eta = \alpha + \beta/(T-T_0)$, the formula to be expected for a salt which dissociates reversibly with temperature. Potassium dichromate does not obey either formula; the suggestion is made that this is due to its decomposition into potassium chromate and chromium trioxide. J. H. A.

4388. Skin Friction of Various Surfaces. S. D. Gehman and G. D. Mallory. *Frank. Inst., J.* 216. *pp.* 339–350, *Sept.*, 1933.—In tests designed to investigate the possibilities of reducing the frictional drag of the outer covers of Zeppelins it was found that the skin friction of a smooth surface, free from nap, approaches a limiting value. With increasing smoothness any further reduction of skin friction becomes increasingly difficult to attain. J. S. G. T.

4389. Measurement of Viscosity by Oscillating Columns. S. Venkataraman. *Indian Journ. Phys.* 8. *pp.* 25–42, *July* 15, 1933.—After reviewing the work done by previous investigators, the paper deals with a new method of finding the viscosity of liquids by measuring photographically the damping of their oscillations in a tube. An expression is obtained for the logarithmic decrement in terms of viscosity coefficient and density of the liquid, radius of the tube and the time of oscillation. The results obtained agree closely with those given in the International Critical Tables. AUTHOR.

4390. Measurement of Viscosities of Liquids Saturated with Gases at High Pressures. B. H. Sage. *Indust. & Engin. Chem.* (*Analytical Edition*) 5. *pp.* 261–263, *July* 15, 1933.—In special connection with a study of the effect of dissolved gases on the viscosity of crude oils, the construction and use of a modified Flowers and Hersey viscometer of the ball and tube type are described. A wide range of viscosities can be measured at relatively high pressures, and over a temperature range up to 100° C. N. M. B.

See also Abstracts 4360, 4380, 4491, 4638.

ASTRONOMY AND ASTROPHYSICS.

COSMOGONY.

See Abstract 4406.

DYNAMICAL PROBLEMS (ASTRONOMICAL).

4391. Motion of a Planetary System of (n + 1) Bodies. G. Krall. *Accad. Lincei, Atti,* 17. *pp.* 927–932, *June* 2, 1933.—Continues previous work [see Abstract 3644 (1932)] and by a mathematical discussion paves the way for a further generalisation, to be announced later. A. D.

NEBULÆ.

4392. Temperatures of the Nuclei of Planetary Nebulæ. R. H. Stoy. *Roy. Astron. Soc., M.N.* 93. *pp.* 588–598, *June,* 1933.—A formula for the temperature of the nucleus of a planetary nebula is developed, on the theoretical basis put forward by Zanstra, and yields the value of the temperature from observations of the nebular spectrum alone. The temperatures so derived for nebulæ for which observational data exist, are rather lower than those found by other methods. G. C. McV.

See also Abstract 4406.

PLANETS.

4393. Refraction and Diffusion in the Atmosphere of Venus. E. Schoenberg. *Preuss. Akad. Wiss. Berlin, Ber.* 1. *pp.* 50–58, 1933.—Recent Mount Wilson observations of the spectrum of Venus, while negative as regards the presence of oxygen and water vapour, have given evidence of the presence of CO_2. The author, from his photometric observations, has previously derived a model atmosphere in two layers, CO_2 and H [see Abstract 767 (1932)]. The value of the horizontal refraction constant for Venus, which enters into his formulæ, is derived from observations of the prolongation of the cusps near inferior conjunction; an error in the method is fully discussed and alters the value of the constant from 44′ to 54′ or 57′. In view of the high value the author rediscusses the relation between refraction constant, diffusion constant, and molecular weight of the planet's atmosphere. The new formula is much less sensitive, but the agreement with CO_2 is very much closer and there is no need to call in the effect of a hydrogen layer. T. L. M.

STARS.

4394. Apparent Distribution of Stellar Luminosities Brighter than 6th Magnitude. E. Öpik, Margaret Olmsted, Georgette Maulbetsch and L. Barnes. *Harvard Coll. Obs., Circ. No.* 381 [13 *pp.*], *June* 20, 1933.—The authors consider that Strömberg's procedure [see Abstract 2787 (1932)] loses more than it gains by using separately the distributions of the τ and υ components of proper motions (instead of the total proper motions) with the distribution of radial velocities, since the total proper motions have about three times greater statistical weight. They have themselves given the distribution of absolute magnitudes of stars brighter than the 6th magnitude [see Abstract 411 (1931)] as calculated from the total proper motions for 19 spectral groups with details corresponding to the statistical resolving power of the method ; these results indicate a smaller number of super-giants than that found by Strömberg. A spectrum luminosity diagram is given, whose abscissæ represent H.D. spectrum, and ordinates visual absolute magnitudes. The main feature indicated by this is the Russell-Hertzsprung diagram, with a region showing avoidance of intermediate late-type luminosities. The region of greatest population of the giant branch joins the main sequence between spectra G0 and A5, but a closer examination shows other gaps in the giant area great enough to appear real. These gaps divide the giant area into 5 separate branches, joining the main sequence at about F8, F2, A3, A0 and B2 ; as if there were 5 superposed Russell diagrams, and within each of the giant branches, increasing visual luminosity is correlated with decreasing temperature. These do not correspond to Strömberg's classes. A. S. D. M.

4395. Photographic and Photovisual Magnitudes of Stars near the Pole. J. Armeanca. *Zeits. f. Astrophysik*, 7. *pp.* 78–105, *July* 24, 1933.—A polar sequence of stars in a region 25′ by 25′ drawn up for the International Astronomical Union (Trans. I.A.U. 1., 1922) has been extended by strictly differential methods to cover a field of 100′ by 100′. The 260 stars included are shown on a chart and listed in a catalogue which gives photographic and photovisual magnitudes. M. A. E.

4396. Systematic Corrections to Magnitudes and an Extension of the Polar Sequence. F. H. Seares. *Astrophys. J.* 78. *pp.* 141–155, *Sept.*, 1933.—It is shown that the statistical error involved in comparisons of magnitudes has not appreciably affected the systematic corrections to various catalogues printed in an Appendix to the Report of the Commission on Stellar Photometry (Transactions of the International Astronomical Union, 4, 140, 1932). These corrections have been slightly revised and utilised to form mean *Pg* and *Pv* magnitudes on the international scale for about 375 polar stars brighter than the tenth magnitude. The mean *Pv* magnitudes have been tested and strengthened by means of special observations supplied by F. E. Ross. The internal agreement of the data from various sources, both in scale and in colour, shows that the corrections applied to the catalogues are substantially free from error and that the mean magnitudes are in close accordance with the international system. The Greenwich effective wave-lengths have been calibrated in terms of colour index. AUTHOR.

4397. Star Streams in the Neighbourhood of 16h R.A. and + 54° Dec. A. Bemporad. *Accad. Lincei, Atti*, 17. *pp.* 882–886, *June* 2, 1933.—Eight more plates have been examined for proper motions [see Abstract 3408 (1933)], and in this region a difference in the frequency of directions of streaming has been found. Proper motions greater than 0″·100 are noted in 17 stars. M. A. E.

4398. Spectrum of Red Stars Belonging to Types M and N. G. Piccardi. *Accad. Lincei, Atti*, 17. *pp.* 952–954, *June* 2, 1933.—It is well known that bands due to certain diatomic molecules appear in the spectra of red stars. Three bands of the monoxide TiO are characteristic of M stars, and three of C_2 of N stars, the presence of one of these compounds seeming to exclude the other, or perhaps where one is intense the other is too faint to be observed. Experiments having been made with flames in the laboratory, it is found that these two molecules behave in the same way as in the M and N stars; and although at present no explanation can be given of their behaviour, the laboratory results may lead to some clue to the stellar problem. M. A. E.

4399. Relative Intensities of Interstellar Calcium and Sodium Lines. C. S. Beals. *Roy. Astron. Soc., M.N.* 93. *pp.* 585–588, *June*, 1933.—The results of the measurements of the intensities of the interstellar lines of calcium and sodium made from the spectra of the stars ξ Persei and 9 Camelopardalis are given. The intensities of the sodium lines are found to be equal to or slightly stronger than those of calcium. The intensity ratio for the two sets of lines also comes out approximately equal for the two stars although the absolute intensities in each case are very different. G. C. McV.

4400. Absorption of Balmer Lines in Stellar Spectra. S. Günther. *Zeits. f. Astrophysik,* 7. *pp.* 106–152, *July* 24, 1933.—The intensities of the Balmer lines in 95 stars of types 0 to F8 have been measured at Göttingen on photographs taken with an objective prism camera. The results are confirmed by comparison with those of other observers, and differences in values of total absorption, line intensity, and line contour, obtained with different instruments, are discussed. Upper and lower limits to the number of atoms producing the Balmer lines are deduced from the observed total absorption. M. A. E.

4401. Continuous Hydrogen Absorption in Spectra of Bright Pleiades Stars. Y. Öhman. *Astron. Iakttagelser Undersökning. Stockholms, Obs.* 11. 10. [19 *pp.*], 1933. *In English.*—For stars of temperatures higher than that corresponding to the maximum intensity of the H lines, increasing line-intensity means decreasing luminosity of the stars [see Abstracts 2796, 3659 and 4198 (1932)]; on the low temperature side of the maximum, the author has shown that the reverse holds good. This may be due to differing values of the surface gravity corresponding to differing numbers of H atoms capable of absorbing the Balmer lines [see Abstracts 4154 (1931) and 2354 (1932)], or to a Stark effect [see Abstracts 1789 (1930) and 2208 (1931)]. To discriminate between these the author investigates the continuous H absorption in a cluster (the brighter Pleiades stars). He describes his instrumental arrangements and observations. Eight plates were used, of which one was taken as the standard; and two points only in the spectrum are measured at about λ4030 and λ3685, the first being in a region free from absorption, the latter where the depression due to continuous absorption is deepest. Measures are made of 21 stars, and show marked relationship between continuous hydrogen absorption and magnitude. A comparison of this series with one of the total intensities of Hγ and apparent magnitude, indicates (in spite of general agreement) a marked difference, since the H lines show a steady decrease with luminosity, but the continuous H absorption displays a typical minimum at mag. 4·2. He examines Ch'ung-Sung Yü's research, and decides against the Stark effect. It seems more likely that continuous H absorption (and also H line intensity) is primarily an accurate temperature measure for the Pleiades and the measure of H absorption obtained gives a refined Hertzsprung-Russell relation for B- and A-type stars. A. S. D. M.

4402. Classification of Stellar Spectra. O. Struve. *Astrophys. J.* 78. *pp.* 73–86, *Sept.*, 1933.—The subdivisions of the Draper classification, intended for statistical investigations with small-dispersion spectrograms, require greater refinement for detailed studies of stellar atmospheres. The first part of this paper deals with the limitations imposed upon such a process of refining by the use of conflicting spectroscopic criteria. A method is suggested by which discrepancies between criteria may be used to throw light upon physical parameters, other than temperature and pressure, which define the appearance of the spectrum. This method is applied to the B-type stars. Peculiarities in the intensities of He I, O II, Mg II, etc., are pointed out and discussed. AUTHOR.

4403. Discontinuities in Colour Equivalents of Stars. A. Brill. *Zeits. f. Astrophysik*, 7. *pp.* 58–77, *July* 24, 1933.—An investigation into the different methods of estimating colour index and temperature of stars (photographic and visual magnitudes, spectrophotometric measures, etc.) confirms the author's previously stated hypothesis that at the region of maximum energy stars radiate as black bodies, but that the energy-curve falls from this towards ultra-violet and also at first towards red more steeply than in normal black-body radiation. [See Abstract 1812 (1929).] M. A. E.

4404. Equilibrium of Distorted Polytropes. Part IV. S. Chandrasekhar. *Roy. Astron. Soc., M.N.* 93. *pp.* 539–574, *June*, 1933.—The theory of polytropic distributions of matter which have been slightly distorted by rotation or by tidal action is worked out further and in great detail. Particular attention is paid to the dependence of the rotational and tidal distortions on the march of the density distribution of the undistorted configuration. The theory of the configurations corresponding to the "Maclaurin ellipsoid" and to "Roche's model" is dealt with more especially. G. C. McV.

4405. Hydrogen Content of the Stars and their Equation of State. G. G. Cillié. *Roy. Astron. Soc., M.N.* 93. *pp.* 574–585, *June*, 1933.—The extent to which stellar models of given mass, luminosity and radius must consist of degenerate matter is investigated. It is concluded that, if a star is not gaseous throughout, there must be an extensive region where the material is in a state between that of a perfect gas and of complete degeneracy. It can also be shown that, unless a stellar model has just the percentage of hydrogen required to make it gaseous throughout, the solution of the fundamental equations in the gaseous part must be centrally condensed. Hence somewhere, the perfect gas law breaks down. These results do not apply to white dwarfs. In the case of diffuse giants very small regions are affected by degeneracy, but for ordinary dwarfs the affected region is comparatively large. The former type of star has a hot and dense core, the latter a large and diffuse core. G. C. McV.

4406. Density of Energy in the Universe. S. A. Korff. *Phys. Rev.* 44. *pp.* 300–301, *Aug.* 15, 1933.—The density of radiant energy given off by stars and luminous matter in the universe is computed and is found to be $6{\cdot}91 \times 10^{-3}$ erg/sq. cm/sec. as received by the earth. In interstellar space, 10^{6} light years from the nearest spiral nebula, the energy density will be between 2×10^{-5} and 2×10^{-4} erg, the former value representing energy from all known nebulæ and the latter an extrapolation to the 25th magnitude, further extrapolation being forbidden by red-shift considerations. The latter figures are considerably smaller than the cosmic-ray energy densities found by Millikan and others. AUTHOR.

4407. Coefficients of Absorption and Opacity of a Partially Degenerate Gas. Bertha Swirles. *Roy. Soc., Proc.* 141. *pp.* 554–566, *Sept.* 1, 1933.—The absorption coefficient of a gas which is in an intermediate state between the perfect gas state and the completely degenerate gas state is calculated. Values are found for the " straight mean " absorption coefficient due to both " bound-free " and " free-free " transitions and for the opacity, considering " free-free " transitions only. The complete opacity coefficient, due to all kinds of transitions, cannot be evaluated owing to its complexity. Application of the results is made to the two-phase standard model of a star. G. C. McV.

4408. Rapid Method for Determining Visual Binary Orbits. H. N. Russell. *Roy. Astron. Soc., M.N.* 93. *pp.* 599–602, *June,* 1933.—A description is given of a method for determining the orbits of visual binaries employing curves in which the distance and position angle are plotted separately against the time. The method has been found to be very rapid. G. C. McV.

4409. Catalogue and Bibliography of Be and Ae Stars. P. W. Merrill and Cora G. Burwell. *Mt. Wilson Observat., Contrib. No.* 471. *Astrophys. J.* 78. *pp.* 87–140, *Sept.,* 1933.—The catalogue, which aims at completeness, lists 410 objects with extensive annotations (much unpublished material) and indexed Bibliography. The meaning of the word " bright " as applied to lines having complex structure is discussed. Six anomalous objects are listed separately. A separate table of P Cygni stars is supplied. The distribution of the stars as to discovery, type, and magnitude is tabulated. Comparisons are made with the total of all stars (from H.D. counts). Class B2 has a greater tendency to emission than earlier or later subdivisions ; the proportion of emission stars decreases very rapidly from B3 to A0. Galactic distribution is analysed. The divergence of the local system from the galactic plane is less strongly marked, owing to greater intrinsic brightness, than for normal B stars. Areas specially rich in Be stars are tabulated and are of two types. The distribution of faint Cepheids resembles that of faint Be stars. T. L. M.

SUN.

See Abstracts 4421, 4434.

GEOPHYSICS.

GEOPHYSICS, APPLIED.

4410. Interpretation of Electromagnetic Survey. A. Belluigi. *Gerlands Beitr. z. Geophys., Angew. Geophys.* 3. 4. *pp.* 365–369, 1933.—The author discusses the problem of deducing from the disturbed electromagnetic field measured at the surface of the earth, the configuration of a buried deposit in which a current is caused to flow, causing the measured disturbance. This inverse problem needs certain assumptions for its solution. The geological data must be utilised as a basis, and the author assumes that the current lines diverge from the source equally in all directions, and that a section of lines can be considered as independent of the rest of the distribution. On this basis, a solution involving elliptic functions is obtained for the determination of the disturbing effect due to a given body. By manipulating this in the light of the geological data, the inverse problem of determining the body from the measured disturbance can be solved. E. L. J.

4411. Electromagnetic Prospecting. Circular Loop Method. W. Nunier. *Gerlands Beitr. z. Geophys., Angew. Geophys.* 3. 4. *pp.* 379–391, 1933.—The theory of the method has been described by J. Koenigsberger [see Abstract 3517 (1930)]. A.c. of frequency between 25 and 300 ∼ is passed through a primary circular insulated loop. At a certain height, the magnetic field of this current is compensated by means of a second current-loop. The vertical component of the secondary field due to currents induced in an underground conductor is measured by an apparatus described, by means of the formula $H = 8{\cdot}3 \times 10^{-9}\nu RJ/\rho$, where ν is the frequency, R the radius of the primary circuit, J the primary current in amperes, and ρ is the specific resistance of the ground. Details are given of a laboratory test of the method, using a tank filled with salt water, and a model apparatus. [See following Abstract.] E. L. J.

4412. Electromagnetic Prospecting. Circular Loop Method. J. Koenigsberger. *Gerlands Beitr. z. Geophys., Angew. Geophys.* 3. 4. *pp.* 392–407, 1933.—The central-loop induction method of electromagnetic prospecting, described by W. Nunier [see preceding Abstract] is specially adapted for searching deep-seated layers in contradistinction to the 4-electrode resistivity method, which is more adapted for layers nearer the earth's surface. The two methods thus supplement each other, and their combination permits the determination of the depths of boundaries from the singular points of the observed curves as well as the computation of the resistivities of the strata. The theory of the method is discussed, including the case when a combination of four loops is used to eliminate the influence of the layers near to the earth's surface. E. L. J.

4413. Electrical Prospecting. Resistivity Method. W. Stern. *Gerlands Beitr. z. Geophys., Angew. Geophys.* 3. 4. *pp.* 408–462, 1933.—A detailed description of the general theory and practice of the resistivity method of electrical prospecting is given, as an introduction to a theoretical discussion of a method for evaluating the effects due to an inclined surface of separation of the upper and lower media. A detailed description follows of the author's apparatus for resistivity measurements, which consists of

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a current-generating arrangement operated by dry batteries, a special type of commutator for converting the current to alternating and re-converting it into direct for the measurement of the potential, a sensitive potentiometer-millivoltmeter arrangement for the potential measurement, and a signalling telephone for communication with the distant electrode operator. The whole outfit is combined into a single compact unit, on stand. Finally, various examples of surveys executed firstly in a Lower Rhenish brown coal region and next in a " terrace " district characterised by typical underground water conditions, are described and the correlation of the resistivity profiles with the borehole data is discussed. An extensive Bibliography of the method concludes the article. E. L. J.

4414. Geophysical Methods of Searching for Water. J. Koenigsberger. *Gerlands Beitr. z. Geophys., Angew. Geophys.* 3. 4. *pp.* 463–525, 1933.—The paper gives a complete treatment of the application of geoelectric methods to the search for water, and refers to other methods and the conditions under which they are most likely to be successful. The chief methods described include resistivity measurements by Wenner's 4-electrode method ; resistivity maps and the method of the Schlumbergers ; induction methods ; electrical waves, and certain auxiliary methods. W. A. R.

4415. Interpretation of the Resistivity Prospecting Method for Horizontal Structures. L. B. Slichter. *Physics,* 4. *pp.* 307–322, *Sept.,* 1933.—The direct problem of deducing from electrical potentials observed at the surface of a horizontally uniform earth the unknown variation of the conductivity with depth reduces to a boundary value problem of unusual type. Its solution for the isotropic case is developed in Part I. In Part II the more usual inverse problem is solved for some special classes of conductivity functions and graphical examples are given as an aid in guiding the interpretation work. In Part III, the anisotropic case is discussed. AUTHOR.

4416. Report of the Fourteenth Annual Meeting of the American Geophysical Union. *Am. Geophys. Union, Trans.* [521 *pp.*] 1933.

HYDROSPHERE, PHYSICS OF THE.

4417. Ocean Currents Produced by Evaporation and Precipitation. G. R. Goldsbrough. *Roy. Soc., Proc.* 141. *pp.* 512–517, *Sept.* 1, 1933.—In this paper the effects of precipitation and evaporation at the surface of an ocean on a rotating globe in reference to the production of steady currents are considered. The ocean is of uniform depth and bounded by two coasts extending from pole to pole along meridians of longitude. When the precipitation and evaporation are distributed over the surface of this ocean in a manner comparable with the probable distribution over the Atlantic Ocean, it is shown that steady currents exist, having a character and direction similar to those observed in the Atlantic Ocean, though not of the same magnitude. AUTHOR.

LAND, PHYSICS OF THE.

4418. Young's Modulus and Poisson's Ratio with Reference to Geophysical Applications. W. A. Zisman. *Nat. Acad. Sci., Proc.* 19. *pp.* 653–665, *July,* 1933.—Young's modulus E and Poisson's ratio σ have been directly determined for 28 samples, 10 × 2 in., of rocks (granite, norite, gneiss, diabase, marble, limestone, and sandstone) for pressures $\not> 78\cdot4$ kg./cm.^{2}. To overcome hysteresis, for E the middle portions of the ascending and descending stress-strain curves, which are straight and parallel, were averaged ; this gave constant results ; σ being measured on the same specimens after E showed little hysteresis. Both E and σ increase with the stress, *e.g.*, by approximately 100 % in some cases when this increased from 2·8 to 78·4 kg./cm.^{2} ; their values are extrapolated to zero stress. Both vary least in rocks for which they are greatest. Both exhibit anisotropy in rocks showing structure differing with direction, *e.g.* marble, limestone and granite ; but also, and so far inexplicably, in norite [see Abstract 2763 (1932)]. C. A. S.

4419. Compressibility and Anisotropy of Rocks At and Near the Earth's Surface. W. A. Zisman. *Nat. Acad. Sci., Proc.* 19. *pp.* 666–679, *July*, 1933.—The linear compressibility β of the rocks in samples $20 \times 1\cdot6$ cm. has been determined, with kerosene as pressure transmitter, for pressures $\not> 840$ kg./cm.^{2}, at 30°, by means of a slightly modified Bridgman piezometer, both uncovered, β_u, and covered with an impermeable copper film, β_c. β_c is always $> \beta_u$, but the difference, which is greatest for porous rocks—marble, granite, and limestone in descending order—decreases with increasing pressure, and is small for 840 kg./cm.^{2}. Both decrease with increasing pressure. The values of $\beta_u \times 10^{13}$, extrapolated to zero pressure, and for 720kg./cm.^{2}, unless otherwise stated, are respectively: granite 19·2–24·7 and 16·7–20·7 ; norite 14·0–16·5 and 12·5–15·7 (600) ; diabase 14·6(0–200), 13·3(400–720) ; peridotite 11·2, 9·37 ; gneiss 20·7, 16·6 ; obsidian 29·6, 29·6 ; sandstone 26·7, 26·0 ; marble 13·9, 12·2 (600) ; limestone 24·7, 24·0 ; dolomite 11·9, 11·9. Rocks with structure varying with direction, *e.g.*, gneiss, sandstone, limestone, and marble, show anisotropy as regards compressibility. [See preceding Abstract.]
C. A. S.

4420. Comparison of Statically and Seismologically Determined Elastic Constants of Rocks. W. A. Zisman. *Nat. Acad. Sci., Proc.* 19. *pp.* 680–686, *July*, 1933.—$\beta_s{}^1$, the static compressibility deduced from E_s and σ_s, the statically determined Young's modulus and Poisson ratio, when compared with β_s determined by direct experiment [see preceding Abstract], is substantially less for diabase, norite, granite, marble, and sandstone, but greater for limestone. Compared with the same quantities determined dynamically, *i.e.*, seismologically, E_d, σ_d and β_d, E_s and σ_s are much $< E_d$ and σ_d, and β_s much $> \beta_d$ for granite, and slightly so for norite, indicating that the more compact the rock the less the difference. σ_s for uncovered samples, when deduced from E_s and β_s for zero stress, tends towards those expected for rock free from cracks and cavities. Thus compact rocks and rocks at depths sufficient to ensure freedom from cracks and cavities may be treated as homogeneous elastic media with identical statical and dynamical constants. C. A. S.

See also Abstracts 4311, 4353, 4354, 4355.

METEOROLOGY.

4421. Diurnal Waves of Atmospheric Pressure, Computed from Observations made on Cruise VII of the Carnegie. Katharine B. Clarke. *Gerlands Beitr. z. Geophys.* 39. 4. *pp.* 337–355, 1933. *In English.*—The instruments and methods used in obtaining hourly values of atmospheric pressure on the Carnegie, 1928/29, are described. By averaging hourly values to give the mean diurnal-variation for every ten degrees of latitude, correcting for non-cyclic change, and subjecting the diurnal curves to harmonic analysis, amplitude and phase of the 24-hourly, 12-hourly, 8-hourly, and 6-hourly waves are obtained. The coefficients of these waves are represented on harmonic dials. The 24-hourly wave is briefly discussed. The coefficients of the 12-hourly wave are compared with other oceanic observations, with Simpson's empirical values, and with values from oceanic islands. The 8-hourly and 6-hourly oscillations are also discussed. The 6-hourly wave from Carnegie data is compared with results of Pramanik's study. AUTHOR.

4422. 11-Year Sunspot Period, Secular Periods of Solar Activity and Synchronous Variations in Terrestrial Phenomena. H. W. Clough. *Monthly Weather Rev.* 61. *pp.* 99–108, *April,* 1933.—The paper supplements earlier ones by the author [see Abstracts 773 (1924) and 803 (1925)]. Changes are made in the Fritz epochs of probable maxima of sunspots dating from 300 A.D., and it is shown that the frequency distribution of the 11-year sunspot intervals derived from the ancient epochs has about the same mean, skewness, and dispersion as that of the Wolfer intervals from 1610. For the whole period of 1600 years the most frequent interval or mode is computed to be 10·94 years, while the normal length of the period computed by a least-square method is 11·067 years. The mean deviation from 11·0 years is ± 1·69 years. The 11-year interval is shown to be systematic rather than fortuitous with a marked tendency for maxima or minima to recur about every third interval. The epochs of maximum and minimum length of the 11-year period yield by the least-square method a normal length of 37·5 years for the long period with an amplitude of 2·4 years. Eliminating the 37-year period, another is found with a normal length of about 83 years and an amplitude of 1·5 years. Further smoothing discloses a 300-year period with an amplitude of 0·5 year, and this in turn undergoes a long secular variation in length roughly estimated at 1400 years. These periods are apparent not only in auroral data, but also in such terrestial data as frequency of severe winters, frequency of Chinese earthquakes, flood and low stages of the Nile, tree growth in Arizona and California, wheat prices in England, raininess, and ice on the Danish coast in winter. The epochs of maxima of the three periods lag somewhat behind the epochs of maximum solar activity and the amount of the lag is proportional to the length of the period. The lags of the 37-year and 83-year epochs exhibit a 300-year period, also a long secular variation—the lag after 1000 A.D. being about two-thirds that previously. R. S. R.

4423. Night Sky Light and the Northern Light. L. A. Sommer. *Zeits. f. Physik,* 84. 3–4. *pp.* 268–270, *July* 26, 1933.—It is shown that after applying some corrections, wave-length measurements made in the long-wave section of the visible spectrum of the Northern Light by Vegard [see Abstract 537 (1933)] are in agreement with measurements made by the author in the corresponding section of the spectrum of the night sky light. J. E. R. C.

4424. Errors in Measurement of Humidity with the Hair Hygrometer. W. Grundmann. *Zeits. f. Instrumentenk.* 53. *pp.* 350–355, *Aug.,* 1933.—Readings of hair hygrometers may be seriously affected by deposits of dust on the hair. Results of tests made on several instruments after long periods of service are tabulated. In one instance, where the hair is heavily encrusted, the indicated humidity is 6 % high at a value of 32 % humidity and 26 % low at 98 % humidity. Measurements, made at various humidities, are described for five different instruments when the hairs of each are coated with several kinds of dust. Pure sand has no deleterious effect, but large deviations are obtained when the deposit contains hygroscopic salts. Methods of cleaning the hair are recommended and may often be successfully applied. In the presence of phosphoric acid and chlorine, however, the hair is liable to undergo chemical change. R. W. P.

4425. Small Wind Meter. E. O. Hulburt. *Rev. Sci. Instruments,* 4. *pp.* 501–503, *Sept.,* 1933.—The paper describes a small, rugged, portable, quick period wind meter for measuring the speed of wind and of gusts of wind. The instrument consists essentially of a mica vane and pointer twisting a torsion wire. AUTHOR.

See also Abstracts 4485, 4545.

SEISMOLOGY.

4426. Effects of Discontinuity Surfaces on the Propagation of Elastic Waves. G. Nishimura and K. Kanai. *Tokyo Univ. Earthquake Research Inst., Bull.* 11. *pp.* 123–186, *June,* 1933. *In English.*—Hitherto the boundary condition assumed in research on the propagation of waves is that in which two elastic solids adhere closely at the boundary surface. In this paper a discontinuity is assumed where two elastic bodies come into contact without adherence and are free to slide over each other without friction. In Part I of the paper the effect of the boundary surface on the propagation of the waves is worked out. When the incident wave is *dilatational,* reflected and transmitted waves are simultaneously generated at the contact surface. Both sets contain dilatational and distortional waves. When the two layers adhere closely these waves are not generated at the boundary. When the wave emerges parallel to the contact surface there is no reflected wave, nor is there when the emergence is at right angles to this surface. When the incident wave is *distortional,* reflected and transmitted waves are also generated, both sets again consisting of dilatational and distortional waves, but such waves are not generated when the surfaces closely adhere. No transmitted waves are produced when the emergence is parallel to the surface of contact, and the amplitude of the reflected wave is equal to that of the incident wave. Up to an angle of emergence of 54° 44′ all generated waves have the properties of surface waves. With an emergence of 45° transmitted distortional waves only are produced. When the emergence is 90° there is also no transmitted wave. Part II considers the initial movement of the free surface. With both types of wave there is no motion of the free surface when the angle of emergence is either 0° or 90°. W. A. R.

4427. Amplitude of Rayleigh Waves on the Surface of a Stratified Medium. T. Suzuki. *Tokyo Univ. Earthquake Research Inst., Bull.* 11. *pp.* 187–195, *June,* 1933. *In English.*—The problem of the amplitude of the Rayleigh wave at the surface is considered, when the medium is covered with a superficial layer. The ratio of the horizontal to the vertical displacement at the surface is worked out, without assuming any limitation of the ratio of the thickness of the surface layer to the wave-length.

W. A. R.

4428. Discontinuous Nature of Love Waves. J. Coulomb. *Comptes Rendus,* 197. *pp.* 525–528, *Aug.* 21, 1933.—When the laws of dispersion of Love waves according to his theory are compared with records good results are not obtained. So instead of assuming a continuous train of waves representing a large range of periods, it is necessary to assume a discontinuous train, each member of which has a period nearly that of the stationary periods. The dispersion is then in agreement with observation. W. A. R.

4429. Recording of Strong Seismic Motion. A. Blake. *Seismological Soc. of America, Bull.* 23. *pp.* 111–127, *July,* 1933.—In designing a seismograph to measure strong motion it is important not to confine attention merely to the maximum acceleration or displacement of the earth motion; these are not sufficient to determine how much a building will be damaged. The fundamental problem is to measure the amount of motion associated with periods to which the buildings respond. These periods are in the range from three-tenths of a second to three seconds. For this purpose a seismograph with a natural period of one second would be better than an instrument of either the accelerometer or displacement-meter type. AUTHOR.

See also Abstracts 4353, 4354, 4418, 4419, 4420.

TERRESTRIAL ELECTRICITY AND MAGNETISM.

4430. Aerial-Earth Current. Part II. H. Noto. *Phys. Math. Soc., Japan, Proc.* 15. *pp.* 238–245, *June,* 1933. *In English.*—Measurements were made with eight different galvanometers to determine the effect of changes of temperature and humidity on the records obtained. These tests showed that changes of temperature affected the rigidity of the suspension and the magnetic field of the permanent magnet, causing changes of zero and of sensitivity. For long-period tests such as the diurnal variation of the aerial-earth current small changes cannot be measured accurately, but for the general electric field under thunder clouds the error is not serious. The error due to humidity becomes negligible if a photographic recording method is used. A bifilar suspension in the galvanometer is recommended, and the galvanometer should record in a place where the air temperature over a long period remains constant. [For Part I see Abstract 3453 (1933).] R. S. R.

4431. Fluctuations of the Earth's Electric Field. A. Dupérier and G. Collado. *Comptes Rendus,* 197. *pp.* 422–423, *July* 27, 1933.—This note deals with the results of two sets of observations, the first taken near Paris, the second near Madrid. Simultaneous observations of the earth's electric field are taken at two points distant 300 m., or multiples thereof. The curves so found show a very striking parallelism which is independent of the state of the sky (except in the presence of Cu-Nb), and of the wind. From their results the authors conclude that it is no longer possible to regard the incessant fluctuations of the field as due to local perturbations only, but to arise perhaps from a larger scale phenomenon. A brief description of the portable apparatus used is given. A. E. M. G.

4432. Variations in the Small-Ion Content of the Atmosphere and their Causes. G. R. Wait. *Frank Inst., J.* 216. *pp.* 147–155, *Aug.*, 1933.—In a recent paper [see Abstract 1218 (1933)] Koller concludes that the small ion content shows both a diurnal and seasonal variation, being greater during the day and in summer than at night and in winter. In the present paper the author discusses the measurements of conductivity taken in recent years at four widely separated stations, two in the northern hemisphere, two in the southern. The variations in conductivity he regards as arising largely from variations in ionic content. Tables are compiled giving values for conductivity both by day and by night in January and in July, and likewise giving mean values for summer and for winter. Another table gives the small ion content over the ocean for summer and for winter during Cruises IV and VI of the Carnegie. These tables indicate no definite differences in ionic content between day and night, or between summer and winter. Dealing with the causes of the ionic variation the author shows how this is dependent upon the production and the removal of the small ions. The latter, particularly in closely settled areas, is dependent on the number of large ions which is greater in winter than in summer, hence a lower winter conductivity. In open country bush fires are common in summer, hence a lower summer conductivity. Thus the investigation shows that the absolute value of the ionic content need not necessarily be dependent on the season of the year or the time of day, and that further investigation is yet required.
A. E. M. G.

4433. Explanation of Phenomena Analogous to Beats in Rapid Periodic Variations of Terrestrial Magnetism. M. Nakano. *Imp. Acad. Tokyo, Proc.* 9. *pp.* 235–238, *June*, 1933. *In English.*—Records of the magnetic elements obtained by magnetographs of high sensitivity show, as a rule, numerous trains of more or less regular waves known as micropulsations. For these Balfour Stewart obtained periods of 30 sec., and Terada, who noted their beat-like feature, found their periods to range from 20 sec. to several minutes. To explain the cause of the pulsations the author considers the atmosphere as a vibrator, and that the two Kennelly-Heaviside layers oscillate more or less vertically with slightly different periods. Calculation gives periods in the neighbourhood of 300 sec., a result which agrees with the longer periods found by Terada.
G. E. A.

4434. Effect of a Solar Eclipse on the Earth's Magnetic Field. S. Chapman. *Terr. Mag.* 38. *pp.* 176–183, *Sept.*, 1933.—The reduction of ionisation in the *E*-layer at a point on the track of the total eclipse of August 31, 1932, has been measured by Henderson; the effect of this on electron-currents flowing in the layer is here examined, and the corresponding magnetic effects are inferred. If this layer is the seat of the currents which produce the solar diurnal magnetic variation (*S*), the magnetic effects of an eclipse should, it is inferred, be apparent, and their nature is described. If, however, *S* is produced in the upper (*F*) ionised layer, the eclipse-effects are likely to be too small for detection with certainty. The magnetic observations during eclipses are discussed, and the opinion is expressed that they show no regular magnetic effect of the type here predicted, and that therefore *S* is probably not produced in the *E*-layer; but a final decision must await further observations.
AUTHOR.

See also Abstract 4485.

RADIOACTIVITY.

4435. New Method of Obtaining Highly Concentrated Emanation. O. Werner. *Zeits. f. phys. Chem.* 165. *Abt.A.* 4–5. *pp.* 391–397, *July*, 1933.—Instead of a radium salt solution, a dry preparation consisting of a radium salt absorbed by ferric hydroxide is used as a source. Neither the emanation nor the mercury used in the seals comes into contact with greased taps or joints. The organic impurities introduced during the preparation of the source are first removed by rapid pumping over a period of 4 weeks. Subsequent collection and purification of the emanation takes about 2 hours, the yield being about 80% of the emanation available. An electric oven for the preparation of glass capillaries, the walls of which are thin enough to allow α-rays to pass through, is described. W. E. P.

4436. Separation of Polonium on Silver in Various Acids. O. Erbacher. *Zeits. f. phys. Chem.* 165. *Abt.A.* 6. *pp.* 421–426, *Aug.*, 1933.—Experiments are described showing that the separation on Ag of Po from its solution in a mineral acid is the result of two separate processes: (*a*) exchange of the more noble Po ions for the less noble Ag ions; and (*b*) assimilation of the Po by Ag_2O_2 (formed by the action of the ozone produced by the .α- particles from Po on Ag) by a species of mixed crystal formation. A black film of very active Ag_2O_2 is obtained on dissolving away with HNO_3 the Ag on which Po has separated. [See Abstracts 878 (1931) and 2589 (1933).] C. A. S.

4437. Chemical Behaviour of Polonium. O. Erbacher and H. Käding. *Zeits. f. phys. Chem.* 165. *Abt.A.* 6. *pp.* 427–432, *Aug.*, 1933.—Previous results bearing on the valency of polonium are discussed. [See Abstracts 3420 (1929), 1896 (1930), 3509 (1931), 488 (1932), and 2589 (1933).] In particular the composition of the supposed pyrogallate is doubtful and no sufficient evidence of trivalency; formation of mixed crystals with other substances is an unsafe guide to valency; and complexes only afford evidence as to the coordination valency. It is therefore concluded that polonium in mineral acid solution is divalent, and not present as the compound ion $(PoO)^{-}$, also that it is more noble than silver, with a normal potential 0·9 volt. C. A. S.

4438. Retardation of α-Particles. G. Mano. *Comptes Rendus*, 197. *pp.* 319–322, *July* 24, 1933.—Experimental results regarding retardation of α-particles and the values of $\overline{E}$, the mean energy of excitation of the atom, deduced therefrom, are compared with the results of Bethe and Bloch's theories. Bethe's theory applies fairly to elements of the lowest, Bloch's to those of high atomic weight. C. A. S.

4439. Magnetic Spectrum of β-Rays from Actinium. T. Graf. *Comptes Rendus*, 197. *pp.* 238–241, *July* 17, 1933.—Using the focussing apparatus of Espine an examination has been made of the β radiation from actinium and several new groups have been discovered. The upper limit of the continuous spectrum of AcC″ has been determined. J. E. R. C.

4440. β-Radiation of Radium E and of the Active Deposit of Actinium. M. Lecoin. *Comptes Rendus,* 197. *pp.* 405–407, *July* 31, 1933.—H_ϱ for 600 β-rays from active deposit of actinium, 250 from Ac″, and 400 from radium E have been measured. The curves relating numbers of rays to H_ϱ are: for Ac″ bell-shaped with maximum at about $H_\varrho = 3000$, and ending at about 6500; that for AcB has a maximum at about 1000, and ends at 3000 — 3500; whilst that for RaE seems to end or change direction at about H_ϱ 5800. RaE emits less than one positive electron per 2000 β-rays. C. A. S.

4441. Theory of β-Ray Disintegration. K. Sitte. *Phys. Zeits.* 34. *pp.* 627–630, *Aug.* 15, 1933.—On the basis of Dirac's theory of "holes," approximate expressions are obtained for the probabilities of emission of electrons by radioactive nuclei. A series of energy distribution curves are given for $\Delta j = 0$ and j and $j' = \pm 1, \pm 2$ and ± 3 for the rotational quantum numbers of nucleus, negative and positive electron respectively. The results are extended to the case of $\Delta j = \pm 1$, which corresponds to the simultaneous emission of a β- and a γ-ray. It is concluded that Dirac's theory is adequate to explain β-ray disintegration and that energy is conserved in the process. F. C. C.

4442. Energy Relations in the β-Ray Type of Radioactive Disintegration. C. D. Ellis and N. F. Mott. *Roy. Soc., Proc.* 141. *pp.* 502–511, *Sept.* 1, 1933.—It is suggested that the upper limit of the continuous β-ray spectrum corresponds to the difference of binding energies of the initial and final nuclei; experimental evidence is given in favour of this hypothesis. It is further suggested that the observed continuous β-ray spectra may be analysed into several curves superimposed, all of which have the same shape; this hypotheis is applied to the β-rays from Ra E, Ra C, Th B, Th C, Th C″. Some new objects for experimental investigation are suggested. AUTHORS.

4443. Energy Principle and Reversibility of the Elementary Processes. G. Beck. *Zeits. f. Physik,* 84. 11–12. *pp.* 811–813, *Aug.* 30, 1933.—The connection between the validity of the energy principle and the reversibility of the elementary processes is noted and an application to the problem of the β-decay is given. J. J. S.

4444. Internal Conversion. J. Solomon. *Comptes Rendus,* 197. *pp.* 401–403, *July* 31, 1933.—The probability of the occurrence of these conversions is calculated [see Abstract 991 (1933)]. C. A. S.

4445. Scattering of Short-Wave γ-Radiation. L. Meitner and H. Kösters. *Zeits. f. Physik,* 84. 3–4. *pp.* 137–144, *July* 26, 1933.—Using an arrangement exactly similar to that used previously for γ-rays of wave-length 6·7 X.U. [see Abstract 3804 (1932)] the authors have investigated the scattering at 90° of γ-rays of mean wave-length 4·7 X.U. by Fe and Pb. In the case of each metal the scattered radiation contains, in addition to that due to Compton scatter, a hard component of the same wave-length as the primary radiation. This result, which agrees with the hypothesis that nuclear scattering occurs without change of wave-length, is discussed in connection with the results obtained by Gray and Tarrant [see Abstract 4385 (1932)]. A calculation of the nuclear scattering coefficients of Fe and Pb is made. W. E. P.

4446. Absorption of Penetrating γ-Rays. W. Gentner. *Comptes Rendus,* 197. *pp.* 403–405, *July* 31, 1933.—The absorption of γ-rays of great energy is attributed jointly to (*a*) Compton effect, (*b*) photoelectric absorption, (*c*) nuclear diffusion, and (*d*) excitation of positive electrons. (*a*) obeys the Klein-Nishina formula, (*b*) is determinable by Gray's method. The coefficient of absorption of lead for γ-rays of λ 4·7–9·3X experimentally determined compared with the coefficient deduced from (*a*) and (*b*) gives by difference the effect due to (*c*). Its effect begins at $\lambda = 12$X, and increases as λ diminishes. C. A. S.

4447. Theory of Atomic Nuclei. Parts IV and V. E. N. Gapon. *Zeits. f. Physik,* 84. 7–8. *pp.* 509–530, *Aug.* 7, 1933.—The first of these papers is largely concerned with the calculation of mass defects of nuclear protons and neutrons. Relations between the mass defects of conglomerates of α-particles and their atomic numbers are deduced and the binding energies of various nuclei are calculated from assumptions as to their constitution. Attention is also paid to the diameter of α-particles. In the second section nuclear transformations, artificial and natural, are investigated and proposed schemes of radioactive decay are discussed. [See Abstracts 2331 and 2924 (1933).] J. E. R. C.

4448. Emission of Positive Electrons by γ-Radiation of Ra (B + C). Grinberg. *Comptes Rendus,* 197. *pp.* 318–319, *July* 24, 1933.—γ-Rays from radium were filtered through 3·5 cm. of lead and then allowed to fall on a plate of lead 2 mm. thick and 18 mm. diameter. The magnetic spectrum indicated 4 positive electrons (energies 0·089, 0·38, 0·38 and 0·62 × 10^6 eV) for 129 negative electrons (maximum energy 1·7 × 10^6 eV). These results agree with those of Curie and Joliot, and support their view connecting emission of positive electrons with nuclear absorption. C. A. S.

4449. Electrostatic Deviation of Positive Electrons. J. Thibaud. *Comptes Rendus,* 197. *pp.* 447–448, *Aug.* 7, 1933.—The author has succeeded in obtaining photographic traces produced by positive electrons and by passing the electrons through an inhomogenous magnetic field and an electric field has confirmed that their properties are those of a particle possessing electronic mass but opposite charge. It has been observed that a strong source of positive electrons is provided by a silver tube containing radium preparations or radiothorium encased in lead. J. E. R. C.

4450. Mass of the Neutron. Irène Curie and F. Joliot. *Comptes Rendus,* 197. *pp.* 237–238, *July* 17, 1933.—It is known that aluminium and boron when subjected to α-particle bombardment emit protons, neutrons and positive electrons. The authors suggest that a proton may be regarded as constituted of a neutron and a positive electron and that occasionally a disintegration proton itself disintegrates into its constituents. From calculations founded upon the disintegration of boron a value of 1·011 is deduced for the mass of the neutron (He = 4) and it is shown that this value agrees with the stability of Be^9 nucleus, whereas Chadwick's value (1·0065) does not. The value is consistent with the phenomena of disintegration of beryllium, aluminium and sodium. Difficulties arise in the case of lithium. J. E. R. C.

4451. Theory of the Neutron. J. J. Placinteanu. *Zeits. f. Physik*, 84. 5–6. *pp.* 370–379, *July* 31, 1933.—As model of the neutron a structure is considered which is supposed compounded from a proton and an electron of negative kinetic energy in Dirac's sense. On this hypothesis the Dirac equation of such a particle is set out and the energy of reciprocal action calculated according to a process worked out by Dirac. J. J. S.

4452. Interaction between Neutrons and Protons. G. C. Wick. *Zeits. f. Physik*, 84. 11–12. *pp.* 799–800, *Aug.* 21, 1933.—Heisenberg's assumption of an exchange interaction between neutrons and protons is applied to the theory of the scattering of neutrons by protons. A departure from the usual behaviour is suggested. The effect may possibly be observed experimentally with sufficiently fast neutrons. F. C. C.

4453. Transmutation of Lithium. M. L. E. Oliphant, B. B. Kinsey and (Lord) Rutherford. *Roy. Soc., Proc.* 141. *pp.* 722–733, *Sept.* 1, 1933.—Experiments are described which lead to the following conclusions: (1) that the disintegration particles produced by proton bombardment of Li nuclei are apparently pairs of α-particles and appear to occur in three homogeneous groups; (2) the disintegration praticles, which again appear to be He nuclei, produced by bombarding Li with ions of the heavy isotope of hydrogen, fall into two groups, one inhomogeneous and the other homogeneous and having a range greater than those due to the light hydrogen isotope. The production of these groups is discussed and satisfactorily explained as due to two different reactions. [See also following Abstract.] J. E. R. C.

4454. Transmutation of Lithium and Boron. P. I. Dee and E. T. S. Walton. *Roy. Soc., Proc.* 141. *pp.* 733–742, *Sept.* 1, 1933.—The disintegration of B and Li by proton bombardment has been investigated with an expansion chamber. The double body disintegration hypothesised by Oliphant, Kinsey and Rutherford [see preceding Abstract] is confirmed. The affect of bombardment with ions of the heavy isotope of hydrogen is also investigated and the existence of two groups, the one homogeneous and the other inhomogeneous, confirmed. The disintegration of B, which is expected to yield three α-particles, was investigated but no definite evidence of a three-body emission was obtained. J. E. R. C.

See also Abstract 4473.

RADIATION.

ABSORPTION AND TRANSMISSION.

4455. Pleochroism and Birefringence of the NO_3^- Ion in Crystals. K. S. Krishnan and A. C. Dasgupta. *Indian Journ. Phys.* 8. *pp.* 49–66, *July* 15, 1933.—An account is given in the paper of measurements on the pleochroism and the principal refractive indices of potassium nitrate crystal in the visible and the near ultra-violet regions of the spectrum. The well-known absorption band at about 3000Å due to the NO_3^- ion is found to be strongly polarised, light vibrations in the plane of the ion being absorbed considerably more than vibrations along the normal to the ionic plane. This absorption band is found to have no influence on the principal refractive indices of the ion. AUTHORS.

4456. Remarkable Optical Properties of the Alkali Metals. R. W. Wood. *Phys. Rev.* 44. *pp.* 353–360, *Sept.* 1, 1933.—Thin films of alkali metals opaque to visible light are highly transparent in the ultra-violet region. The point in the spectrum at which transparency commences moves toward shorter wave-lengths with decreasing atomic number as follows: Cs 4400; Rb 3600; K 3150; Na 2100; Li 2050 Å. The transparency continues as far down the spectrum as the investigations have gone (1860 Å). In this region the phenomenon of plane polarisation by reflection is observed. The reflecting powers of these metals for different wave-lengths have been measured. From these measurements and also from the Brewsterian angles for plane polarisation, the refractive index of a potassium film has been calculated. The values range from 0·90 at 2147 Å to 0·50 at 3100 Å. Since the refractive index is less than unity total reflection takes place, although the critical angle is not sharply defined. Interference maxima and minima in the spectrum of light reflected from a metal film permit a rough determination of the film thickness. AUTHOR.

See also Abstracts 4689, 4701.

COLORIMETRY.

See Abstracts 4474, 4554.

ELECTRO-OPTICAL AND MAGNETO-OPTICAL EFFECTS.

4457. Kerr Effect with Isomeric Benzene Derivatives. G. Otterbein. *Phys. Zeits.* 34. *pp.* 645–646, *Aug.* 15, 1933.—In a previous publication [see Abstract 2762 (1931)] the author has discussed whether on analogy with the possibility of calculating the total electric moment of a molecule vectorially from the separate moments, the separate substituents in a molecule contribute a characteristic amount towards the Kerr constants. Application of this conception is now made to monochlorobenzene and the three dichlorobenzenes, and the results found to be in accord with prediction. The data are computed by extrapolations from measurements in carbon tetrachloride and hexane, experimental details being given.

H. H. Ho.

4458. Dispersion of the Kerr Electro-Optic Effect in the Short Infra-Red Spectrum. L. R. Ingersoll and W. R. Winch. *Phys. Rev.* 44. *pp.* 399–405, *Sept.* 1, 1933.—Measurements of the Kerr electro-optic effect have been made on carbon disulphide, nitrobenzene, *o*-nitrotoluene, chlorobenzene, and halowax oil over a spectral region extending from the sodium lines to beyond 1·6μ (2·1μ for CS_2), or some three times the wave-length range previously investigated by other observers. A spectroradiometric method was used, involving effectively the measurement of the minor axis of the ellipse into which the plane polarised radiation is converted by the electrostatic stress in the Kerr cell. The potentials across the cell of 3300 to 31,000 volts were furnished by a kenotron and condenser equipment. The Havelock formula for electro-optic dispersion $K = C(n^2 - 1)^2/n\lambda$ and two others have been tested in connection with the results. In most cases the agreement with the Havelock formula is somewhat better than with the others and for CS_2 this law fits the observed dispersion almost within the limits of experimental error throughout the spectral range investigated. Beyond 1μ the dispersion of all the liquids is much the same and the agreement with all these formulæ reasonably good. In fact, for this region the Kerr effect is very nearly proportional to the inverse wave-length. AUTHORS.

See also Abstracts 4306, 4487.

FLUORESCENCE AND PHOSPHORESCENCE. LUMINESCENCE AND AFTERGLOW.

4459. Fluorescence of Solutions and Gases. A. Boutaric and J. Bouchard. *J. de Physique et le Radium*, 4. *pp*. 324–332, *June*, 1933.—Starting from a hypothesis of Francis Perrin concerning the exponential decrease, expressed as a function of the concentration, of the fluorescent power of a solution referred to unit mass the authors study the variation of intensity of the fluorescent light emitted by a rectangular vessel as a function of the concentration of the fluorescent substance and the dimensions of the vessel. They show that the relative concentration at the optimum of fluorescence depends in a complex manner on the experimental conditions. The same conclusions apply to gases. H. L. B.

4460. Fluorescence of Sulphur Dioxide. W. Lotmar. *Zeits. f. Physik*, 83. 11–12. *pp*. 765–785, *July* 8, 1933.—With the zinc line 2100 Å a strong resonance fluorescence is obtained in the short wave-absorption region of SO_2 which is relatively simple and can be arranged in a scheme of terms with three fundamental frequencies but the arrangement is not actually certain because of numerous accidental coincidences of vibration levels. This spectrum is different from spectra encountered in the long wave region. Experiments have been made also with admixture of foreign gases and it is suggested that on account of the proximity of the predisssociation limit the life period of the molecules excited by the zinc line is essentially short and therefore conversion of the originally excited states into neighbouring states through impacts does not appear. W. R. A.

4461. New Phosphors of the Hydrated Sulphates of Aluminium and other Metals Activated by Organic Substances. M. Travnicek. *Ann. d. Physik*, 17. 6. *pp*. 654–678, *July*, 1933.—It has been found possible to prepare strongly phosphorescent substances by incorporating fluorescent organic substances such as fluorescein in transparent bases. The conditions necessary for such preparations have been studied in detail with hydrated inorganic salts. It is considered that the phosphorescence is attributable to the formation of strain centres. A spectroscopic study has been made of the phosphorescence of aluminium sulphate–fluorescein and of the effect of temperature on the colour and corresponding changes in relative intensity of the bands. It is established that the grain size has a close relation to the intensity, the latter falling off when, by grinding, the grains are reduced below a certain size. This result is considered to explain the effect of fluxes on the intensity of CaS phosphors. The excitation wave-lengths are not identical with those which decompose the fluorescein. In the ground substance Al may be replaced by Be, Zr, Th, and the sulphate radical by selenate. J. E.

4462. Solarisation of Luminiferous Calcite. S. Iimori. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 439. *pp.* 220–231, *Aug.*, 1933. *In English.*—A continuation of the author's previous work and ideas [see Abstracts 2947 and 2948 (1933)]. It is shown that the theory of luminotransformation by stages leads to an exponential law of phosphorescent decay. This is experimentally verified with Nabeto calcite. A semi-quantitative determination of the total output of light with samples exposed for various lengths of time to a Hg vapour lamp indicated that with prolonged exposure repeated solarisation occurs. This effect is apparently analogous to photographic reversal. Using coloured filters, no difference in the rate of decay of different parts of the spectrum could be detected. J. E.

4463. Elementary Processes in Highly-Rarefied Flames. V. Kondratjew. *Phys. Zeits. d. Sowjetunion,* 4. 1. *pp.* 57–75, 1933. *In German.*—The luminous spectrum that occurs in the chemical reaction $K + HgCl_2$ is investigated in the region between 7700 to 4000 Å for different pressures of admixed nitrogen. The linear dependence of the quantity J_0/J, which appears as a measure of the weakening of the intensity, is ascertained for nitrogen pressures down to 0·25 mm. of mercury for the case of the violet potassium line. A calculation is made of the probability with which the KCl molecules that excite the line spectrum of K become unactivated. Specially devised experiments show that the exciting mechanism is the same for the red as for the violet K lines. A discussion is given of the nature of the active molecules as exciters of the luminous spectra produced by chemical reactions. H. L. B.

INTERFERENCE. DIFFRACTION AND SCATTERING.

4464. Diffraction at Small Spheres near the Focus of Convergent Spherical Waves. F. Möglich. *Ann. d. Physik,* 17. 8. *pp.* 825–862, *Aug.*, 1933.—This paper is a contribution to the study of the colours of colloidal solutions at higher concentrations, which cannot be predicted accurately on Mie's theory. The problem considered is that of a spherical particle situated in a convergent beam of spherical waves near the focus (*e.g.*, the ultra-microscope). The nature of the resulting diffraction phenomena, their dependence on the size and position, relative to the focus, of the particle, and the influence of the angular aperture of the beam, are investigated, account being taken of the secondary effects due to neighbouring particles. It is found that, if the aperture is less than 60° and the particle is not near the focus, the results are much the same as for a plane wave, but that near the focus, modifications are introduced, and these are reproduced graphically for special cases. Tables are also given for the magnitudes of some of the quantities involved, and these simplify the calculation of particular details of the phenomenon. C. B. A.

4465. Scattering and Absorption of Electromagnetic Radiation by a Small Sphere. G. Beck and P. Wenzel. *Zeits. f. Physik,* 84. 5–6. *pp.* 335–355, *July* 31, 1933.–The scattering and absorption of a light wave by a small absorbing sphere is calculated and the result of the calculation is applied to the discussion of the scattering and absorption by atoms and atomic nuclei. J. J. S.

4466. Interferometry. Part II. Construction, Testing and Use of Reflection Échelons for the Visible and Ultra-Violet Regions. W. E. Williams. *Phys. Soc., Proc.* 45. *pp.* 699–726, *Sept.* 1, 1933.—The practical details of the construction and methods of testing reflection échelons are considered. The various methods of mounting are compared. A method is described whereby the instrument can be used for wave-length measurements. It is further shown that the échelon provides an alternative means of standardising length units in terms of a wave-length of light. [For Part I see Abstract 4253 (1932).] AUTHOR.

4467. Eagle Mounting for a 3-m. Concave Grating. W. H. J. Childs. *Journ. Sci. Instruments,* 10. *pp.* 272–274, *Sept.,* 1933.—The paper describes the design of an Eagle mounting for a 3-m. concave grating. By making use wherever possible of standard engineering parts, and by the adoption of kinematical principles in the design, an especially simple and economical form has been evolved. AUTHOR.

See also Abstract 4544.

PHOTOCHEMISTRY (INCLUDING PHOTOGRAPHY).

4468. Behaviour of Dry Mixtures of Hydrogen and Chlorine in the Light. F. Bernreuther and M. Bodenstein. *Preuss. Akad. Wiss. Berlin, Ber.* 6. *pp.* 333–355, 1933.—Five series of experiments, based on accounts of a variety of methods already published, are described ; all lead to the conclusion that when irradiated, intensively dried hydrogen-chlorine mixtures react in the same manner as do moist mixtures. The contrary result reported by Coehn, Jung, and Heymer is ascribed to the presence of inhibiting impurities and not to the absence of water. H. F. G.

4469. Photochemical Union of Chlorine and Hydrogen in the Presence of Oxygen. D. L. Chapman and J. S. Watkins. *Chem. Soc., J. pp.* 743–745, *July,* 1933.—In the photochemical union of hydrogen and chlorine, hydrogen can become an inhibitor, and oxygen ceases to be an inhibitor when the partial pressure of the hydrogen falls below a certain value. A discussion is given of possible formulæ to express these results on the basis of the formation of water in the reaction. A determination was made of the highest attainable ratio of the number of water molecules to those of hydrogen chloride ; this ratio can exceed 0·5, but it has not been ascertained whether it approaches asymptotically to a fixed value. N. M. B.

4470. Photographic Reciprocity Law Failure for Radiations of Different Wave-Length. J. H. Webb. *J.O.S.A.* 23. *pp.* 316–323, *Sept.,* 1933.—A study is made of the reciprocity law failure at different wave-lengths, high speed blue sensitive and panchromatic emulsions being employed. It is found that the reciprocity curves for radiations of different wave-length are identical in shape provided that the comparison is so effected that points of equal times of exposure coincide. This equality is interpreted as meaning that points of equal exposure time on the

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reciprocity curves correspond to conditions of equal rates of photochemical activity of the exposing radiation. Determinations (for varying wave-lengths) are made of the critical frequency, f_c, at which intermittent and continuous exposure of the same average intensity produce the same density. It is believed that the equality of the values of f_c found in the various cases signifies that the rates of the discrete photochemical processes, in exposures of equal time and density, are the same for radiations of any wave-length. A. H.

4471. Improved Process for Physical Development of Plates, Films and Lantern Slides. A. F. Odell. *Indust. and Engin. Chem.* 25. *pp.* 877–879, *Aug.*, 1933.—Attention is directed in this paper to the unusual and little known merits of the process of physical development, and an improved and simplified procedure is described which has been applied to practically every make and type of plate and film on the market. This method obviates the difficulties inherent in the processes of Sterry, Lumières and Seyewetz, and of Lüppo-Cramer, in which large excesses of silver are used which serve no useful purpose whilst high acid concentrations unduly tender the gelatin films. The finished negatives do not appear at all like the ordinary negative, but are thinner and more delicate in appearance, while possessing equally as good printing qualities; they may be pink, blue, violet, and almost blue-black by transmitted light, whilst by reflected light they appear yellow or grey. The image is built up by surface deposition of the silver, and is not within the emulsion, so that it can be seen as a positive by reflected light. Dichroic fog is entirely absent. Several laboratory and technical applications of the method are pointed out where the process should have an outstanding advantage. H. H. Ho.

4472. Dependence of Reflection Density of Photographic Paper on Orientation with Respect to Incident Light. R. E. Owen and T. D. Sanders. *Phot. J.* 73. *pp.* 398–402, *Sept.*, 1933.—It is shown that the reflection density of photographic paper is dependent upon the angle between the machine direction of the paper and the plane of incidence of the illuminating beam. Evidence is brought forward which points to the change in density being caused by the light which is specularly reflected from the gelatin-air interface of the gelatin-coated fibres at the paper surface, the amount of this light reaching the collecting lens of the density meter changing with the orientation of the paper. The effect is considerable in the case of natural surface papers, amounting to as much as 15% in the measurement of the maximum density. With baryta-coated papers, which constitute the bulk of photographic papers, the effect is small and for most purposes can be neglected. It is suggested that the reflection density of a paper be taken as the mean of the maximum and minimum densities of the paper as determined by rotation of the paper in the density meter. A practical method for approximating to this value with a single measurement is indicated. AUTHORS.

4473. Response of a Photographic Emulsion to α-Rays. T. R. Wilkins and R. N. Wolfe. *J.O.S.A.* 23. *pp.* 324–332, *Sept.*, 1933.—The equation $D = D_{\mathbf{max}}(1 - e^{-c_1 N})$ developed by Kinoshita for single-layer emulsions has been shown to hold for commercial emulsions. A derivation of this formula is given which shows that the probability constant c_1 should be the same for thick as for thin emulsions. A useful relation $s_0 = k/\pi\rho^2$ between s_0, the number of grains under a sq. cm. of emulsion surface, k, the number of grains in the depth of the emulsion, and $\pi\rho^2$, the average grain size has been deduced and tested. To eliminate the density due to fluorescence, chromic acid desensitisation has been used. Photographic effects due to mechanical pressure have on these desensitised plates, been found to be reversed by α-rays as well as by the other radiations previously reported.

Average grain-size measured microscopically $= 0\cdot 14\mu^2$
$\pi\rho^2$ from desensitised plate No. 93 $= 0\cdot 08$
$\pi\rho^2$ from desensitised plate No. 100 $= 0\cdot 12$
$\pi\rho^2$ from $s_0 = k/\pi\rho^2$ $= 0\cdot 12$

Chromic acid desensitisation has been found to be effective only for a limited time. AUTHORS.

See also Abstract 4342.

PHOTOMETRY.

4474. Conditions for Securing Accuracy in Spectrophotometry. F. Twyman and G. F. Lothian. *Phys. Soc., Proc.* 45. *pp.* 643–659; *Disc.*, 659–662, *Sept.* 1, 1933.—The paper sets forth basic principles in the design and use of spectrophotometers The first part deals with absorption spectrophotometry in its application to chemistry and includes consideration of the various methods in use, *viz.*, photographic, visual, and photoelectric. The optimum conditions for each method are stated and the three types of method are compared. The second part is concerned with spectrophotometry as a means of describing a radiation, as for instance in connection with colorimetry, the comparison of light sources and quantitative spectrum analysis. AUTHORS.

See also Abstract 4342.

POLARISATION.

4475. Polarisation of Resonance Radiation. P. Soleillet. *Comptes Rendus*, 197. *pp.* 316–318, *July* 24, 1933.—The author's results [see Abstract 590 (1930)] indicate that P as a function of θ in the case treated by Mitchell [see Abstract 4209 (1931) and 4321 (1932)] should depend on a single parameter. This is shown to be the case by means of van Vleck's results [see Abstract 515 (1926)]. C. A. S.

See also Abstract 4455.

RADIATION, EMISSION.

4476. Standards of Thermal Radiation Maintained by the Bureau of Standards. W. W. Coblentz and R. Stair. *Bureau of Standards, J. of Research*, 11. *pp.* 79–87, *July*, 1933.—The basis of the lamp standards of radiation, established and maintained by the Bureau of Standards since 1913, is the black body using the Stefan-Boltzmann constant of total radiation $\sigma = 5\cdot 70 \times 10^{-12}$ $\text{watt/cm}^2/\text{deg.}^4$ In this paper the present status of the value of the constant of total radiation is reviewed, and it is concluded that, for the present, the basis of the lamp calibration remains unchanged. These carbon-filament lamp standards of thermal radiation maintained by the Bureau of Standards (S227) were intercompared after a lapse of 12 years and found in good agreement with the original standards which were established in 1913 by direct comparison with a black body. Two reproductions of these standards which, according to published reports, showed rapid deterioration in radiant flux, were recalibrated. No deterioration, to 2 parts in 840, could be measured in the radiation emitted by one of these lamps which had been in use 8 years. In the other lamp an increase in radiant flux, amounting to about 1 %, was found. This was caused by a hot spot in the filament, probably resulting from usage or perhaps by injury in shipment. In a life test, a standard of radiation was operated for 245 hours before an increase in radiant flux became appreciable, and at the expiration of 300 hours this increase amounted to only 0·8 %. One section is devoted to the technique of operation, and specific directions are given to insure high precision. AUTHORS.

4477. Radiation Emitted at Very Rapid Collisions. W. Heitler. *Zeits. f. Physik*, 84. 3–4. *pp.* 145–167, *July* 26, 1933.—The brake of retardation radiation at collisions of a particle, whose energy is great when compared with mc^2, is calculated to a first approximation for a nucleus with help of the Dirac relativistic wave equation. The result is that the probability of the emission of a light quantum is then great if light quantum and particle are scattered *forwards*. The effective cross section for this process is actually $(e^2/mc^2)^2 \times 1/137$. The retardation thereby caused is consistent with the measurements of the cosmic radiation. On the other hand the application of the theory to these processes lies already in a region where the known difficulties of the negative energy state and the electron radius occur. J. J. S.

4478. Absorption of Penetrating Radiation by Different Elements. E. G. Steinke and H. Tielsch. *Zeits. f. Physik*, 84. 7–8. *pp.* 425–429, *Aug.* 7, 1933.—The absorption of penetrating radiation by different elements at sea-level was determined with a high-pressure ionisation chamber. It was estimated that 1·00 cm. of Pb, 1·18 cm. of Fe or 3·5 cm. of Al are equivalent. Calculation shows, however, that for the extra-nuclear electrons, 1·00 cm. of Pb = 1·29 cm. of Fe = 3·46 cm. of Al, or including the nuclear electrons, 1·52 cm. of Fe or 4·22 cm. of Al. The assumption of Regener [see Abstract 2988 (1933)] that all electrons participate in the scattering of penetrating radiation is, therefore, not in agreement with these experiments. F. C. C.

4479. Straight Line Relation for Penetrating Radiation Coincidences and its Experimental Validity. W. Kolhörster and L. Tuwim. *Zeits. f. Physik*, 84. 9–10. *pp.* 629–636, *Aug.* 12, 1933.—Tuwim's theory for a single tube counter [see Abstract 2985 (1933)] is extended to include coincidence measurements. With 2 counters arranged in G-formation the law was verified experimentally for the 3 well-known angular positions. The deviations at sea-level amount to about 2 %, with a lead shield 10 cms. thick and to about 4 % with an unscreened apparatus. Applications of the theory are suggested. F. C. C.

4480. Distribution of Ionising Particles of Penetrating Radiation in Relation to the Magnetic Meridian. J. P. T. Viljoen and B. F. J. Schonland. *Phil. Mag.* 16. *pp.* 449–456, *Aug.*, 1933. *Supplement.*—An investigation of the direction of arrival of the ionising particles associated with the penetrating radiation has been made at sea-level in Cape Town (mag. lat. 31° S.). The numbers of particles from magnetic north, south, east, and west were compared by means of a coincidence

counter. The differences found were (1) north-south, 0·4 ± 1·5 %; (2) west-east, 1·5 ± 2·6 %; (3) north-west, 2·9 ± 2·6 %; (4) north-east, 4·3 ± 2·6 %. It is concluded that any charged particles of extra-terrestrial origin are accompanied by a larger number of secondary particles generated in the atmosphere by some radiation which is not affected by the earth's magnetic field. The north-east difference suggests that the majority of the primary particles are positively charged.
AUTHORS.

4481. Passage of Fast Corpuscles through Ferromagnetic Material. C. F. v. Weizsäcker. *Ann. d. Physik*, 17. 8. *pp*. 869–896, *Aug.*, 1933.—The calculated deflection of fast corpuscles in their passage through ferromagnetic material depends upon whether the effective field is B, the magnetic induction or H, the free magnetic field. From classical theory, the circular current model suggests B, but the purely magnetic model suggests H. Quantum theory conceives the scattering of the particles as arising from their interaction with the spin moment of the rest electrons in the ferromagnetic material. A first approximation shows that B is the effective field; higher approximations may be neglected. The importance of these conclusions is discussed from the standpoint of the determination of the energy of penetrating radiation. The existing formulæ for stopping power are shown to be inapplicable to metals where the electrons are practically free and for Li the new formula indicates an increase in stopping power of about 30 %. F. C. C.

4482. Secondary and Tertiary Particles Produced by Cosmic Rays. J. H. Sawyer, Jr. *Phys. Rev.* 44. *pp*. 241–245, *Aug.* 15, 1933.—A search, by means of Geiger counters, was made for scattered cosmic rays in the region around a large iron block but no scattering could be detected. Experiments were tried with one counter just above a metal plate and two counters, placed side by side below it. It was found that the metal plate increased the number of triple coincidences between the three counters. The increase in the number of triple coincidences rose to a maximum and then diminished to zero as the thickness of the metal plate was increased. This effect was observed with plates of lead, tin and aluminium. It was greatest with lead and very small with aluminium. The results can be explained by supposing that secondary particles from the air above the apparatus produce tertiary particles in the metal plate which pass through the lower counters. The absorption coefficient of the air secondaries in lead was found to be 0·5 and that of the lead tertiaries to be 2·58. AUTHOR.

4483. New High-Altitude Study of Cosmic-Ray Bands and Determination of Their Total Energy Content. I. S. Bowen, R. A. Millikan and H. V. Neher. *Phys. Rev.* 44. *pp*. 246–252, *Aug.* 15, 1933.—(1) The Millikan-Cameron cosmic-ray curve extending for 80 equivalent m. of water below the top of the atmosphere up to 7·5 m. has here been extended by accurate measurements in the critical region from 7·5 m. up to 3·34 m. (29,200 ft.) of water beneath the top in latitude 34, and up to 4·5 m. (22,000 ft.) in the equatorial belt. The comparison of the two curves permits of the separation of the magnetically deflectable particles from the primary non-deflectable cosmic rays. (2) The rays thus separated reveal with much definiteness a banded structure of not less than three rather widely separated components, and by virtue of the high altitudes reached fix with considerable certainty the absorption coefficient of the least

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penetrating band. This single band is responsible for 90 % of the cosmic-ray ionisation of the atmosphere. The absorption coefficients of the more penetrating bands of indefinite number (not less than two) cannot be sharply determined, but their general character is indicated herein, as well as the limitations of this method of their determination. (3) These measurements combined with Bowen and Millikan's stratosphere observations, which agree well with the present measurements in the region in which they overlap, make possible the plotting of a complete cosmic-ray intensity curve extending from the lowest depths to the top of the atmosphere. (4) The graphical integration of this curve shows that the total energy reaching the earth in the form of cosmic rays is about one-half that coming to the earth in the form of heat and light from the stars. This makes the cosmic-ray energy in the universe from 30 to 300 times that of all other radiant energies combined. AUTHORS.

4484. Cosmic-Ray Positive and Negative Electrons. C. D. Anderson. *Phys. Rev.* 44. *pp.* 406–416, *Sept.* 1, 1933.—A determination of the specific ionisation of cosmic-ray particles by counting the number of drops per cm. along tracks on cloud chamber photographs, and by measurements of the energy loss in lead, has shown that the great bulk of the cosmic-ray particles of positive charge are positive electrons. The primary ionisation was found to be about 31 ion pairs per cm. in air at S.T.P., but the total energy loss represents about 120 ion pairs per cm. in air. Approximately the same values of specific ionisation were found for the positives as for the negatives. Positive and negative electrons occurred in nearly equal numbers and had similar distributions in energy. Several track photographs are given. In view of the discovery that hard γ-rays of ThC″ give rise to positives and negatives in pairs, similar to the effects found in cosmic-ray studies, it is concluded that the absorption of the ThC″ rays is due in part to that by free negative electrons and in part to a nuclear effect which results in the production of pairs of positive and negative electrons. Cosmic-ray studies show that this nuclear effect represents the predominant part of the absorption for the range of energies as high as those of the cosmic rays and that the absorption by free negative electrons is relatively small. J. J. S.

4485. Fluctuations of Cosmic-Ray Ionisation. J. W. Broxon, G. T. Merideth and L. Strait. *Phys. Rev.* 44. *pp.* 253–257, *Aug.* 15, 1933.—In a recent paper [see Abstract 2994 (1933)] the writers reported observations of the cosmic-ray ionisation at four-hour intervals during a period of fifteen consecutive days. No regular diurnal variation was observed. The usual dependence of the ionisation upon barometric pressure was observed, but no direct dependence upon atmospheric potential gradiant, atmospheric temperature or absolute humidity was apparent. E. O. Hulburt suggested to the writers that there might be some correlation between fluctuations of the cosmic-ray ionisation and terrestrial magnetic activity. Defining the cosmic-ray ionisation " character " as the product of the average for a particular day by the difference between the maximum and minimum ionisation values for that day, the writers found a considerable correspondence between the ionisation " character " curve and the curve representing the magnetic character of days during the period of the observations. Further similarities with the corresponding " character " curves for the atmospheric potential gradient and the absolute humidity were brought out. Certain important consequences are pointed out. AUTHORS.

4486. Improved Cosmic-Ray Meter. A. H. Compton and J. J. Hopfield. *Rev. Sci. Instruments*, 4. *pp.* 491–495, *Sept.*, 1933.—An improved cosmic-ray meter is described in detail. Directions for its use in the measurement of cosmic rays are given; and various errors and ways of minimising them are discussed. AUTHORS.

REFLECTION. REFRACTION AND DISPERSION.

4487. Optical Anisotropy of Molecular Crystals. Part I. Experimental. S. B. Hendricks and M. E. Jefferson. *J.O.S.A.* 23. *pp.* 299–307, *Sept.*, 1933.—A description is given of the methods used in the preparation of the crystals. An improved Retger's method was employed to obtain the density, care being taken to eliminate voids and foreign inclusions. The errors do not exceed 1×10^{-4}. A technique was devised to overcome the difficulty of high vapour pressure of the crystals used, by the preparation of suitable surfaces. The total reflection method with an Abbé-Pulfrich refractometer was used and independent values were obtained for the refractive index (n) by the immersion method under a microscope, agreement being obtained to $\pm 0{\cdot}003$. Errors in n do not exceed 5×10^{-4} and were smaller for the dispersions. The data obtained are summarised in a table. The "apparent" anisotropy of molecules is quite closely similar in the liquid and solid states. Dispersion curves are given for the various compounds. Freshly prepared surfaces of crystalline naphthalene were found to have variable minimum refractive indices which after some time approach the same limit. The intermediate refractive indices of such surfaces are constant. Possible explanations of the phenomenon are given. R. S. R.

4488. Studies in Refractive Index. Part IV. A. M. Taylor and A. King. *J.O.S.A.* 23. *pp.* 308–312, *Sept.*, 1933.—In this paper an account is given of an extension of the second method for determining refractive indices of liquids in thin films, previously described in Part I of this series. The apparatus was modified mechanically and optically and an air thermostat built to contain it. The critical angle of reflection from glass to liquid was determined for three normal fatty acids, undecylic, lauric and myristic, in the molten state. The surface layers of the liquid phase were observed to become suddenly birefringent within a narrow range of temperature immediately above the temperature of solidification, this indicating orientation of the molecules of the molten acid to a depth of at least a wave-length or so of visible light. [For Part III see Abstract 4083 (1933).] AUTHORS.

4489. Experiment on Dispersion. R. C. Evans. *Cambridge Phil. Soc., Proc.* 29. *pp.* 417–422, *July* 30, 1933.—Theory and experimental details are given for an experiment in which anomalous dispersion is produced by the successive action of a prism and a grating. The difference between the refractive indices of the prism at two wave-lengths thence deduced is in good agreement with that observed directly. C. B. A.

4490. Dispersion Measurements upon Potassium Bromide and Potassium Iodide in the Infra-Red. K. Korth. *Zeits. f. Physik*, 84. 11–12. *pp.* 677–685, *Aug.* 21, 1933.—Experimental details are given of the method used for preparing from the melt the large crystals from which the prisms investigated were cut. The dispersion measurements are carried out at 38° C. with a spectrometer arrangement having a prism of the substance under investigation, the energy distribution at the exit slit being investigated by means of a radiomicrometer with a KI window. The range of wave-lengths investigated is 1 to 29μ for potassium iodide and 14 to $26{\cdot}7\mu$ for potassium bromide. In the former case the wave-lengths up to 18μ are determined by means of an auxiliary infra-red spectrometer with NaCl or KCl prism. Between 14 and 29μ the wave-lengths are measured interferometrically (error $0{\cdot}1$ to $0{\cdot}2\mu$), the interferometer constant being determined with an accuracy of 1 to 1½ % by interferometric measurements in the visible. L. A. W.

4491. Viscosity of Optical Glass. W. H. Wadleigh. *Bureau of Standards, J. of Research,* 11. *pp.* 65–78, *July,* 1933.—This is a report of a laboratory investigation of the viscosities of six optical glasses at high temperatures. A modified Searle type of concentric cylinder viscometer was used. The method of calibrating the viscometer is described, including the determination of frictional and "end effect" corrections. The important factors and formulæ involved in the computation of viscosities from experimental data are given. A graph is shown of the logarithms of the viscosity values for a given glass plotted against the corresponding temperatures. Equations are given expressing the mathematical relations of viscosity to temperature. Included is a brief discussion of the viscosity changes resulting from volatilisation and pot dilution during measurement, and of the consequent difficulty in determining the exact composition at the moment measurement is made. AUTHOR.

4492. Prism Surface Planity and Collimation in Precise Minimum-Deviation Refractometry. L. W. Tilton. *Bureau of Standards, J. of Research,* 11. *pp.* 25–57, *July,* 1933.—Care in the optimum translational adjustment of a prism in order to permit the symmetrical use of all aperatures is always necessary on account of aberrations inherent in lens systems. Such prism adjustments are advisable also because of slight curvatures of most prism surfaces. When prisms are at all times correctly located with respect to the axes of collimator, telescope and spectrometer, the departures of the surfaces from planeness may then be appreciably greater than has hitherto been recognised as allowable. Moreover, it is shown that the latitude in collimation becomes sufficiently large to permit making all necessary refocussings with the telescope, even when using objectives with the usual type of colour correction. Tolerances, corresponding to an error of $\pm 1 \times 10^{-6}$ in index of refraction, are evaluated for curvature of prism surfaces, translational adjustment of the prism, eccentricity of prism-table axis, and collimator refocussing. AUTHOR.

4493. Sectometer: New Optical Method of Testing the Microtom Measurer. H. Elpel. *Zeits. f. Instrumentenk.* 53. *pp.* 355–358, *Aug.,* 1933.—The author reviews the former methods used in the examination of rock sections and the errors which arise from the purely subjective tests with the sense of touch, the hair test, and the difficulties of laboratory tests due to either small magnification or to the small field of view, short objective distance and lengthy procedure for large magnification. A form of apparatus is then described which provides means for giving sideways displacement and rotation of the specimen to get different inclinations to the light and a form of dark field illumination. It combines the advantages of a large field of view and sufficient objective distance with large magnification without their disadvantages. It can be used quickly, gives reliable results, and shows up the finest qualitative differences of different sections. R. S. R.

See also Abstracts 4330, 4455, 4456, 4466, 4542, 4543, 4544, 4545, 4580, 4596.

SPECTROSCOPY.

4494. Under-Water Spark Spectrum of Cerium. J. S. Badami. *Indian Journ. Phys.* 8. *pp.* 19–24, *July* 15, 1933.—An account is given in the paper of measurements made with a 10-ft. concave grating, of the wave-lengths of a number of lines in the under-water spark spectrum of cerium. AUTHOR.

4495. Wave-Lengths of the Vacuum Spark Spectra of Carbon, Nitrogen and Oxygen in the Extreme Ultra-Violet. B. Edlén. *Zeits. f. Physik,* 85. 1–2. *pp.* 85–106, *Aug.* 29, 1933.—Since the spectra of C, N, and O often appear as a large number of closely spaced lines in vacuum spark spectra, it is of importance for the spectroscopy of the extreme ultra-violet to know their wave-lengths accurately, so as to be able to use them as reference lines. Tables are given containing the estimated intensities, the wave-lengths and the wave-numbers of 312 C lines between 200 and 1923 Å, 253 N lines between 140 and 1242 Å, and 619 O lines between 104 and 1371 Å. The error is less than 0·01 Å for sharp lines. The lines in the region 115 to 550 Å are also reproduced in a series of enlarged spectrograms. L. A. W.

4496. Excitation of Balmer Lines. F. Zimmer. *Ann. d. Physik,* 17. 5. *pp.* 553–580, *July,* 1933.—The intensities of the β, γ and δ Balmer lines, both moving and at rest, as excited by canal-rays in hydrogen, have been measured at various pressures. The values for the former intensity are found to agree better with Palacios' theory than with that of Wien. The ratio of corresponding intensities of two lines increases with the pressure, but is independent of voltage, while the intensity of the continuous spectrum increases with both. F. S.

4497. Attempts to Extend the Helium Spectrum by Excitation of Both Electrons. A. H. Rosenthal. *Zeits. f. Physik,* 84. 11–12. *pp.* 794–798, *Aug.* 21, 1933.—An attempt is made to find lines in the visible spectrum corresponding to transitions between helium terms with two excited electrons. The difficulties in the way of the excitation of such lines and the attempts made to overcome them are discussed. No transitions of this nature are established with certainty. J. E. K.

4498. Arc Spectrum of Mercury. H. Beutler. *Zeits. f. Physik,* 84. 5–6. *pp.* 289–303, *July* 31, 1933.—The higher members of the principal series $^1S_0 - m^1P_1$ and $^1S_0 - m^3P_1$ were measured, both in emission and absorption, in the region 1400–1200 Å using a vacuum spectrograph. Wave-lengths of lines as far as $m = 14$ are given to $\pm 0{\cdot}02$ Å and the values compared with those calculated from the long wave series. From intensity ratios under various conditions of excitation it is concluded that the term 7318 cm.$^{-1}$ has the structure $(5d)^9(6s)^2\,6p^1\,P_1$. An empirical formula for the perturbation of such series is given. F. S.

4499. Arc Spectrum of Neodymium. S. P. de Rubies. *Comptes Rendus*, 197. *pp.* 33–35, *July* 3, 1933.—The region investigated covers 2400 Å–3100 Å. Measurements were made as far as 3200 Å and between 3154 Å and 3199 Å all the lines, save two, listed by Takvorian [see Abstract 3492 (1931)] have been found. F. S.

4500. Width of Absorption Lines of I_2. I. I. Agarbiceanu. *Comptes Rendus*, 197. *pp.* 38–39, *July* 3, 1933.—The fluorescence of I_2 excited by the 5461 Å line of mercury has been examined at 44° and 124° C. for the following cases: (1) a tube exhausted to 0·1 mm. of Hg; (2) a tube containing nitrogen at about 10 mm. pressure; and (3) a tube containing oxygen at the same pressure. Oxygen is found to destroy the polarisation of fluorescence. The causes of widening are discussed. F. S.

4501. Absorption Spectra of the Samarium Ion in Solids. Part III. F. H. Spedding and R. S. Bear. *Phys. Rev.* 44. *pp.* 287–295, *Aug.* 15, 1933.—The absorption spectrum of $Sm(BrO_3)_3 \cdot 9H_2O$ has been studied at four temperatures between 20° and 298° K. The temperature variation in the absorption intensities is used to determine the location of excited lower levels situated at 39 and 68 cm.$^{-1}$ above the basic one. Other levels from 100 to 230 cm.$^{-1}$ above the normal state are probable. Between 78° and 20° many lines show a marked change, becoming double at the lower temperature. This is shown to be compatible with a splitting of the levels into new ones at 0, 37, 45, 67 and 82 cm.$^{-1}$. Selection rules are indicated which show two apparently independent sets of these levels; 0, 37, 82 and one group of high levels; and 0, 45, 67 and another group of upper levels. This low-temperature splitting may be due either (1) to actual removal of degeneracy or (2) to development of two types of Sm^{+++} ion, differing in crystal environments. Either effect could presumably be caused by small changes in the crystal dimensions and symmetry. The hexagonal bromate shows less extension and complexity of upper multiplets and the excited lower levels are closer to the basic one than in the less symmetrical monoclinic chloride previously studied. [For Parts I and II see Abstracts 233 and 234 (1933).] AUTHORS.

4502. Tables of Atomic Spectral Terms of Carbon, Nitrogen and Oxygen. B. Edlén. *Zeits. f. Physik*, 84. 11–12. *pp.* 746–766, *Aug.* 21, 1933.—Tables are given containing many new terms of the spectra of the following: CI, CII, CIII, CIV, NII, NIII, NIV, NV, OII, OIII, OIV, OV, OVI. The new terms are mainly derived from work in the extreme ultra-violet. A. C. M.

4503. Intensity Measurements of Lines in the Principal Series of Rubidium and Cæsium. H. J. Hübner. *Ann. d. Physik*, 17. 7. *pp.* 781–815, *Aug.*, 1933.—Burners are described which involve the use of an oxyhydrogen flame and of compressed coal gas into which the salts of rubidium and cæsium are fed by means of an appropriately modified Beck centrifugal dusting apparatus. The temperature of the flame amounted to 2850° abs. and 2176° abs., respectively. By means of a photographic photometric method the true "intensity ratio" ($I V_w$) of the components of the second and third member of the principal series of cæsium was measured in a so-called "infinitely thin" layer of the source of light. In the second rubidium line the value 2·55 was obtained in the oxyhydrogen flame and 2·58 in the compressed gas flame. In the compressed gas flame the value

3·25 was obtained for the third rubidium line and 8·0 for the third cæsium line. In all three doublets there was found a pronounced departure from the value 2 demanded by the intensity rule of Burgers and Dorgelo. From the measured dependence of the line-absorption on the intensity of the lines the I. V.$_{w}$ was determined indirectly for the second rubidium line and came out as 2·53. Another value obtained indirectly came out as 2·58. H. L. B.

4504. Intensity Distribution and Breadth of the Predissociation Lines of the Al-H Molecule. L. Farkas and S. Levy. *Zeits. f. Physik*, 84. 3–4. *pp.* 195–207, *July* 26, 1933.—The breadth and intensity distribution in relation to the rotation quantum number in the single predissociation lines of the Al-H molecule have been estimated by a Fabry-Perot interferometer. W. R. A.

4505. Abnormal Increase in Intensity of the Mercury Lines 5461, 4358 and 4047 Å due to Very Dry Hydrogen and Other Gases. A. Güntherschulze and H. Betz. *Zeits. f. Physik*, 84. 7–8. *pp.* 402–411, *Aug.* 7, 1933.—Using as kathode a heated tungsten filament, an investigation is made of the increase of intensity of the yellow and green Hg lines at a mercury vapour pressure of 0·002 mm. Hg in thoroughly dried gases, the results being represented graphically as functions of the energy of the electrons and of the pressure of the added gas. In the case of hydrogen the intensity ratio green/yellow increases rapidly both with increase of electron velocity and also with increase of hydrogen pressure. With nitrogen and argon the effect is slight; while with He and Ne it is not observed. The different gases are found to show a corresponding behaviour in a glow discharge. The intensities of certain lines of the gases as well as of the mercury yellow and green lines are determined at different distances from the kathode in the regions of the kathode fall and the negative glow. The paper concludes with a summary of the conditions necessary for the intensification of the Hg lines 5461, 4358 and 4047 Å. A marked decrease in the intensity of these lines observed upon addition of oxygen is explained as due to removal of mercury vapour by oxidation. L. A. W.

4506. Nuclear Moments and Their Dependence upon Atomic Number and Mass Number. N. S. Grace. *Phys. Rev.* 44. *pp.* 361–364, *Sept.* 1, 1933.—Nuclei are grouped into four classes depending upon whether Z and M (atomic number and mass number, respectively) are even or odd. A summary of the nuclear mechanical and magnetic moments which have been experimentally observed is given. This summary indicates similarities within each nuclear class and definite differences between classes both as to mechanical and magnetic moments and to nuclear *g*-factors. These results suggest a correlation between nuclear moments and the periodic table; namely, that nearly all nuclei which have large magnetic and mechanical moments lie in columns of the periodic table with Z odd, while nuclei occurring in columns for which Z is even generally have zero, or small magnetic moments and zero, or small mechanical moments. The incompleteness of the present data is emphasised. AUTHOR.

4507. Nuclear Spin of Arsenic. A. S. Rao. *Zeits. f. Physik*, 84. 3–4. *pp.* 236–247, *July* 26, 1933.—The hyperfine structures of about 20 important AsII lines in the region 6300 Å to 4300 Å are investigated by means of Lummer-Gehrcke plates and etalons of various thicknesses. The nuclear spin of arsenic is found to be $\frac{3}{2}\cdot\frac{h}{2\pi}$, which agrees with the value found independently by Tolansky. The hyperfine structure intervals of the terms $5s^3P_1$, $5s^3P_2$, $5p^3D_2$, $5p^3P_2$ and $5p^1P_1$ given by Tolansky are confirmed and the intervals for the terms $sp^3\,{}^3D_2$, $sp^3\,{}^3D_3$, $5p^3D_2$ and $5p^3D_3$ are calculated. The *f* selection rule, the interval rule and the intensity rule corresponding to a value I = 3/2, are found to be generally valid. J. E. K.

4508. Hyperfine Structure in the Arc Spectrum of Fluorine. J. S. Campbell. *Zeits. f. Physik*, 84. 7–8. *pp.* 393–401, *Aug.* 7, 1933.—The hyperfine structure of the principal lines of the fluorine spectrum (FI) is investigated by means of a Fabry-Perot interferometer. The value of the nuclear moment of fluorine comes out as ½, and the interval factors of most of the known terms of the configurations $2p^43p$ and $2p^43s$ are determined. Comparison of these factors with those of the analogous terms of the bromine (BrI) spectrum indicates that the *g*(I) value for fluorine is probably somewhat greater than for bromine. L. A. W.

4509. Magnetic Transformation of the Hyperfine Structure in Mercury. D. R. Inglis. *Zeits. f. Physik*, 84. 7–8. *pp.* 466–473, *Aug.* 7, 1933.—The quantum mechanical problem of the Paschen-Back transition in the hyperfine structure of the Hg line λ2537 is treated in a simple way. The transformations for the calculation of the intensities may be deduced from the extreme cases for which the vector model holds good. In order to compare the results with absorption measurements at various field strengths Doppler spreading and fading through absorption are calculated by such an investigation. The comparison confirms Schüler and Keyston's determination of the nucleus spin of the Hg isotope. A small spectroscopic isotope displacement was found. J. J. S.

4510. Hyperfine Structure in the Spark Spectrum of Cadmium. E. G. Jones. *Phys. Soc., Proc.* 45. *pp.* 625–626, *Sept* 1, 1933.—The Cd II spectrum has been investigated in the region λλ 4200–8500 with Fabry-Perot etalons. Of the thirteen lines examined, only λ 8067 has any structure. From the structure of the $6^2S_{\frac{1}{2}}$ term it is calculated that the *g*(I) factor of the odd isotopes is – 1·25 proton magnetons. AUTHOR.

4511. Duration of Existence of Excited Atomic States. V. Weisskopf. *Phys. Zeits. d. Sowjetunion*, 4. 1. *pp.* 97–113, 1933. *In German.*—A mathematical paper in which the author remarks that the problems connected with the duration of existence of excited atomic states led in the older quantum mechanics to many contradictions ; but that these contradictions have been mostly removed by the newer mechanics. He proceeds to give a systematic treatment of some of these problems. Use is made of the Kramers-Heisenberg " Streuformel." T. B.

4512. Wave-Mechanical Calculation of Rydberg Correction of Helium Terms. E. A. Hylleraas. *Zeits. f. Physik*, 83. 11–12. *pp.* 739–764, *July* 8, 1933.—Following on earlier papers the author calculates all the discrete term values of helium (for an excited atom). If the polarisation effect is neglected the screening effect and the exchange effect come out particularly satisfactorily for the S-terms. Allowance may afterwards be made for the polarisation effect which plays an important part in the P-terms and the predominant part, indeed, in the D-terms. To do this the polarisation is regarded as a quadratic Stark effect of the ion in the field of the outer electron. The calculation of the polarisation is not performed with perfect accuracy (small terms of a higher order are neglected) but may be regarded as sufficiently exact, except in the case of the S-terms, which are separately treated. H. L. B.

4513. Oscillation Structure in the Spectrum of Carbon Tetrachloride. J. Horiuti. *Zeits. f. Physik.* 84. 5–6. *pp.* 380–392, *July* 31, 1933.—The sum of the frequencies of two normal vibrations of CCl_4 (315 and 457 cm.$^{-1}$) is equal to a third vibration frequency of this molecule (774 cm.$^{-1}$). This caused splittings in the vibration structure first indicated by Fermi. These splittings are accurately calculated, and also for the cases where already in the initial condition vibrations were excited by the temperature. The agreement of the results with observation is not quite satisfactory. J. J. S.

4514. Charge Distributions for the Normal Atoms from Boron to Neon. F. W. Brown, J. H. Bartlett, Jr., and C. G. Dunn. *Phys. Rev.* 44. *pp.* 296–299, *Aug.* 15, 1933.—Hartree functions have been obtained for normal boron. The energy parameters of the 1*s*, 2*s* and 2*p* electrons are found to be 15·50, 0·910 and 0·446 respectively. By use of the function for the normal electron configurations of B, O, F and Ne, and an interpolation process, single-electron wave functions for normal carbon and nitrogen have been found. Values of the radial functions of the 1*s* and 2*s* electrons at $r = 0$ for the atoms B, F and Ne have also been tabulated. AUTHORS.

4515. Band Spectrum of Copper Hydride. A. Heimer and T. Heimer. *Zeits. f. Physik*, 84. 3–4. *pp.* 222–235, *July* 26, 1933.—A new method is applied for exciting the CuH Bands in the electric arc. New nuclear vibration levels $v^{1} = 3$ and $v^{11} = 3$ and 4 are established in the previously known $^1\Sigma^* - {}^1\Sigma$ system. A new system $^1\Sigma^{**} - {}^1\Sigma$ is discovered. If the normal state of the Cu molecule corresponds to the ground state ^2S of the atom, the course of the potential curves indicates that the $^1\Sigma^*$ state dissociates into the $^2D_{3/2}$ state and that the $^1\Sigma^{**}$ state dissociates into the $^2D_{5/2}$ state. J. E. K.

4516. Second Positive Group in the Nitrogen Spectrum. D. Coster, F. Brons and A. van der Ziel. *Zeits. f. Physik*, 84. 5–6. *pp.* 304–334, *July* 31, 1933.—New measurements of the rotation structure of the bands 0 → 0, 1 → 0, 2 → 3, 3 → 3, 4 → 2 and 4 → 4 have been made. Rotation constants have been calculated and intensity distribution compared with quantum-mechanical considerations. A new type of perturbation resulting in certain lines being weakened has been found and the isotope effect has been measured. F. S.

4517. Emission Spectrum of Molecular Hydrogen in the Extreme Ultra-Violet. C. R. Jeppesen. *Phys. Rev.* 44. *pp.* 165–184, *Aug.* 1, 1933.—A 2m. grazing incidence vacuum spectrograph is used to photograph the H_2 emission spectrum between 810A and 1375A, more than 1400 new lines being obtained. The $2p^1\Sigma - 1s^1\Sigma$ (B – A) system is extended, bands ending on the three lowest vibrational levels of the normal electronic state now being included. The system $2p^1\Pi_{cd} - 1s^1\Sigma$ is reanalysed. Molecular constants are calculated for the observed vibrational levels of the normal $1s^1\Sigma$ state, the new B values fall regularly on a smooth $B_v : v$ curve, so that it is no longer necessary to assume a perturbed $v = 0$ level. The curve has, however, a positive curvature for low v values in contradistinction to the known negative curvature for higher v values. Data from the visible spectrum is combined with the new data to give the rotational constants for the $2p^1\Sigma$ level. The Λ-type doubling in this state gives two " effective " values for each of the rotational constants. In this instance the true B value is that given by the *c* component levels, the B_v values here fall on a smooth $B_v : v$ curve. But the B_v values from the *d* component levels do not lie on a smooth curve ; there are a number of rotational perturbations and one apparent vibrational one ($v = 3$). The B_e values for the $1s^1\Sigma$ (A), $2p^1\Sigma$ (B) and $2p^1\Pi_{cd}$ (C) states are determined as 60·8715, 19·987 and 31·288 cm.$^{-1}$, respectively. The value of ν_e for the $2p^1\Sigma - 1s^1\Sigma$ system is 91,708 cm.$^{-1}$ and for $2p^1\Pi_{cd} - 1s^1\Sigma$ 100,049 cm.$^{-1}$ These new values differ appreciably from earlier ones, the changes being due to fresh data and re-analysis of the older data. A. H.

4518. Band Spectrum of Barium Hydride. G. Funke. *Zeits. f. Physik*, 84. 9–10. *pp*. 610–628, *Aug*. 12, 1933.—The band spectrum of barium hydride lying between 5950 Å and 7500 Å is photographed. A band system, $^2\Pi - {}^2\Sigma$, whose $0 \rightarrow 0$ band was previously known, lies in this region. The $1 \rightarrow 1$, $1 \rightarrow 0$, $0 \rightarrow 1$ and $2 \rightarrow 1$ bands of this system are here measured and analysed. J. E. K.

4519. Double Band at 3660 Å in the Spectrum of Carbon Dioxide. R. Schmid. *Zeits. f. Physik*, 84. 11–12. *pp*. 732–739, *Aug*. 21, 1933.—Continuing the analysis of spectrograms of the emission bands of CO_2 with and without magnetic field [see Abstract 5000 (1932)], it is pointed out that the bands between 3661·5 and 3670 Å differ from other bands previously described in respect of their complex structure and the clearly observable effect of a magnetic field. Since no other bands of the same structure can be found in the spectrum, the assumption seems justified that the bands under consideration form a true double band with a doublet separation of 57·2 cm.$^{-1}$ The distance between successive lines indicates that (in consequence of the symmetry of the molecule and the absence of nuclear spins of the oxygen atoms) every alternate rotation term is absent. The influence of the field upon the lines is related to the Zeemann effect of the doublet band at 2900 Å : in both cases what is principally observed is displacement and broadening. Both the rotational structure and the Zeemann effect make probable the existence of a not unimportant κ-type doublet (as a consequence of the rotation of the carbon atom about the axis joining the nuclei). Although a complete analysis is not yet possible, the structure appears to be similar to that of a $^2\Sigma \leftrightarrow {}^2\Pi$ band of a diatomic molecule. L. A. W.

4520. Rotational Spectrum of Water Vapour. J. Kühne. *Zeits. f. Physik*, 84. 11–12. *pp*. 722–731, *Aug*. 21, 1933.—A new vacuum spectrometer for the long-wave infra-red is described. Preliminary experiments are made to test the grating used and to compare the source of radiation adopted (namely a heated platinum disc coated with hard glass) with other sources. The apparatus is then used to investigate the rotational absorption spectrum of water vapour between 30 and 90 μ. It is observed that with water vapour alone at a pressure of 13 mm. the absorption maxima are only faint, whereas they become more and more marked with increasing addition of air. This effect is explained as due to collisional broadening of the lines at constant spectral slit width. The results obtained are compared with those of other workers. Good agreement is found with the values of Rubens, and in addition some new lines are observed. L. A. W.

4521. Far Infra-Red Absorption Spectra of Ammonia and Phosphine Gases under High Resolving Power. N. Wright and H. M. Randall. *Phys. Rev*. 44. *pp*. 391–398, *Sept*. 1, 1933.—A spectrometer of large aperture employing a reflection grating of the echelette type ruled to concentrate radiation in the region of the 1st order of 90μ has been applied in the special range from 60 to 125μ. The resolving power was several times that hitherto obtained in this region. The pure rotation absorption spectra of water vapour and of the gases NH_3 and PH_3 have been investigated. In the case of NH_3 the absorption lines shown as single in the observations of Badger and Cartwright have been found under the higher resolution of the present work to be doublets with a doublet separation of 1·33 cm.$^{-1}$ Despite the similarity of structure of the molecules PH_3 and NH_3 the pure rotation lines of PH_3 exhibit no trace of a doubling. The frequencies of the PH_3 lines and the mid-frequencies of the NH_3 doublets have been shown to agree very accurately with formulæ of the type $\nu_J J^{-1} = BJ - DJ^3$. Determinations of the moments of inertia A of NH_3 and PH_3 have been made and in the case of NH_3 the measurement of the doublet separation has led to a slight revision of the values for the moment of inertia C and for the molecular dimensions obtained by Dennison and Uhlenbeck. AUTHORS.

4522. Absorption Spectrum of Sulphur Dioxide. A. Jonescu. *Comptes. Rendus*, 197. *pp.* 35–37, *July* 3, 1933.—The spectrum in the ultra-violet has been measured using quartz and grating spectrographs The bands due to normal and activated molecules are distinguished and a formula proposed for giving the positions of a number of these bands. The constants are compared with those obtained in the infra-red and from the Raman effect. F. S.

4523. Absorption Spectrum of Diatomic Bismuth. G. M. Almy and F. M. Sparks. *Phys. Rev.* 44. *pp.* 365–375, *Sept.* 1, 1933.—The absorption spectrum of diatomic bismuth, previously observed but not analysed, has been obtained by heating pure bismuth in an atmosphere of nitrogen in a carbon-tube furnace at temperatures from 850 to 1500° C. and also by heating in an evacuated quartz tube up to 1200° C. Four systems of bands have been photographed and analysed : (1) the visible system, 4500 Å to 7900 Å, which consists of over 300 bands which have been arranged in square array extending to $v' = 59$ and $v'' = 55$. (2) The ultra-violet system of 40 bands, 2600Å to 2900Å, which has its lower state in common with (1). (3) The far ultra-violet system, below 2250Å, which is very diffiult to obtain and measure but almost certainly has the same lower state as (1) and (2). (4) The violet system, appearing only at temperatures greater than 1000° C. ((1), (2) and (3) appear below 900° C.), which consists of 15 sharp band heads, 9 " continuous bands " and a series of closely spaced diffuse bands. Its lower state is the upper state of (1) and its upper state is presumably crossed by a repulsive state which accounts for the diffuse and continuous bands. There is also an extended continuum in the neighbourhood of 3100Å. Assuming that the lowest state dissociates into two normal $^4S_{3/2}$ bismuth atoms, a set of potential energy curves for the molecular states has been drawn with satisfactory extrapolation into atomic states in all cases. The estimated heat of dissociation of the lowest state is 1·71 volts. AUTHORS.

4524. Absorption Spectrum of Chlorine Dioxide. Z. W. Ku. *Phys. Rev.* 44. *pp.* 376–382, *Sept.* 1, 1933.—The spectrum of the visible and ultra-violet absorption bands of ClO_2 has been studied under various dispersions. The band heads were measured with high precision. The result of the vibrational analysis shows that the bands may be represented

by $\nu = 20957{\cdot}2 + 302{\cdot}9\,(v_1' + \frac{1}{2}) - 2{\cdot}3\,(v_1' + \frac{1}{2})^2 + 721{\cdot}68\,(v_2' + \frac{1}{2}) - 2{\cdot}797\,(v_2' + \frac{1}{2})^2 + 271{\cdot}2\,(v_3' + \frac{1}{2}) - 4{\cdot}42\,(v_1' + \frac{1}{2})\,(v_2' + \frac{1}{2}) - 3{\cdot}9\,(v_1' + \frac{1}{2})\,(v_3' + \frac{1}{2}) - 5{\cdot}9\,(v_2' + \frac{1}{2})\,(v_3' + \frac{1}{2}) - 529{\cdot}0\,(v_1'' + \frac{1}{2}) - 1104{\cdot}8\,(v_2'' + \frac{1}{2}) - 954{\cdot}4\,(v_3'' + \frac{1}{2}) + 4{\cdot}8\,(v_3'' + \frac{1}{2})^2$, yielding three normal frequencies for each upper and lower electronic state. The essential difference between the present analysis and that of the previous investigators is discussed. Rotational lines are partially resolved on the plates taken in the second order with a 21-foot grating. Two fundamental and one combination bands in the region 4–11 μ were located with a self-recording spectrometer, and these are compared with the recent observation of Bailey and Cassie [see Abstract 4973 (1932)]. Molecular constants have been calculated from a characteristic determinant given by Yates. They are found to be consistent with the observed isotope effect of chlorine. AUTHOR.

4525. New Type of Diffuse Molecular Spectrum: Light Absorption and Photochemical Decomposition of Chromyl Chloride Vapour. R. de L. Kronig, A. Schaafsma and P. K. Peerlkamp. *Zeits. f. phys. Chem.* 22. *Abt.B.* 4. *pp.* 323–332, *Aug.*, 1933.—The absorption spectrum of chromyl chloride vapour CrO_2Cl_2 in the visible region at room-temperature is photographed with a grating spectrograph of high dispersion. A system of five diffuse absorption bands without edges is repeated periodically with a practically constant interval of 136 cm.$^{-1}$ from about 6000Å towards the violet. The light absorption is accompanied by a dissociation process, the formation of clouds of finely divided dust being observed in the track of the beam. In all probability the reaction involved is the splitting off of a Cl_2 molecule from the chromyl residue CrO_2, but this is not proved. In the proposed theoretical explanation the spectrum is regarded as a Condon " diffraction band " [see Abstract 1057 (1929)]. It is assumed that the dissociation corresponds to a transition into an electronic state in which the interaction of the groups is represented by a repulsion curve. The observed nature of the absorption spectrum can then be explained by suitable choice of the form of this curve. L. A. W.

4526. Classification of Unrecorded Band-Systems of Neutral OH Determination of the Constants. T. Tanaka and Z. Koana. *Phys. Math. Soc., Japan, Proc.* 15. *pp.* 272–290, *July*, 1933. *In English.*—Extending earlier work [see Abstract 4098 (1933)], a large number of previously unclassified lines in the OH spectrum are allocated to bands. The λλ 3122, 2875 bands are extended whilst 63 lines are grouped into a new band with head at λ 2677. A new band at λ 2946 also accounts for more than 100 lines. A band at λ 3185 is analysed but this analysis does not agree with that of Johnston and Dawson [see Abstract 3571 (1933)]. The rotational constants are calculated in every case, and a study is made of the σ-type doubling. A. H.

4527. New Band System of Beryllium Oxide and the Structure of the BeO Molecule. Luise Herzberg. *Zeits. f. Physik*, 84. 9–10. *pp.* 571–592, *Aug.* 12, 1933.—A new band system of BeO is discovered in the red and near infra-red of the spectrum of an arc between metallic beryllium electrodes. The system represents a $^1\Pi \rightarrow {}^1\Sigma$ transition. The lower state, $^1\Sigma$, is identical with the lower state of the visible bands and is probably the lower state of the molecule. The fine structure of all the bands appearing on the plates is analysed. A null-line formula is obtained from the analysis. It is shown that the lower state of the ultra-violet bands is probably identical with the upper state of the red bands. The courses of the potential curves for the four known electron states of the BeO molecule are calculated and their relation to the terms of the separated atoms is discussed. The electron configurations to which the various states of the molecule may be ascribed are given and the molecular constants are tabulated. J. E. K.

4528. Intensity Distribution in the Spectrum of Beryllium Oxide. R. C. Johnson and E. G. Dunstan. *Phil. Mag.* 16. *pp.* 472–478, *Aug.*, 1933. *Supplement.*—Quantitative intensity determinations are made for the $^1\Sigma \rightarrow {}^1\Sigma$ BeO system, peak intensities of the unresolved bands being employed. A striking feature of the intensity distribution is the strong development of the (0, 0) sequence, the higher members being much stronger than is generally the case. An attempt is made to determine the effective temperature of the emitting molecules, but no satisfactory correlation with the temperature of the arc employed is obtained. A. H.

4529. Intensities of Bands in the Spectrum of Boron Monoxide. A. Elliott. *Phys. Soc., Proc.* 45. *pp.* 627–634, *Sept.* 1, 1933.—The intensities of the α bands of BO have been measured by means of an arrangement which gives the intensity of a whole band. Precautions for the detection of systematic errors are described, and the probable error is estimated at about ± 5 %. The observed intensities have been compared with theoretical ones calculated from wave mechanics. Morse's wave function is found to give much better results than the harmonic wave function, but shows some discrepancy from theory for higher vibrational states. The theory using the harmonic wave function has been applied to some previous results for the intensities of the β bands of BO. Fair agreement is found for the most part, but a few bands show discrepancies greater than the experimental error. The intensity ratio of the $B^{11}O$ and $B^{10}O$ bands has been measured for two of the α bands. The result, 3·5 : 1, is in satisfactory agreement with a previous determination of the isotope intensity ratio in the β bands of BO, 3·66 : 1. AUTHOR.

4530. Intensity Distribution in a Band System of Symmetrical Triatomic Molecules. Z. W. Ku. *Phys. Rev.* 44. *pp.* 383–390, *Sept.* 1, 1933.—The Franck-Condon theory has been extended to a study of band intensities of a triatomic molecule of the general type XY_2. The most probable transitions are found to be

$$v_1' = \begin{cases} A_1 \pm B_1 v_1^{1/2} \pm C_1 v_2^{1/2} + D_1 v_1 + E_1 v_2 - F_1 v_1 - G_1 v_2 + H_1 (v_1 v_2)^{1/2} \\ A_1 \pm B_1 v_1^{1/2} \mp C_1 v_2^{1/2} + D_1 v_1 + E_1 v_2 - F_1 v_1 - G_1 v_2 - H_1 (v_1 v_2)^{1/2} \end{cases}$$

$$v_2' = \begin{cases} A_2 \pm B_2 v_1^{1/2} \pm C_2 v_2^{1/2} + D_2 v_1 + E_2 v_2 - F_2 v_1 + G_2 v_2 + H_2 (v_1 v_2)^{1/2} \\ A_2 \pm B_2 v_1^{1/2} \mp C_2 v_2^{1/2} + D_2 v_1 + E_2 v_2 - F_2 v_1 - G_2 v_2 - H_2 (v_1 v_2)^{1/2} \end{cases}$$

$$v_3' = \begin{cases} (\nu_3/\nu_3')\nu_3 \\ (\nu_3'/\nu_3)\nu_3 \end{cases}$$

where the v's with and without a prime refer to the vibrational quantum numbers of the upper and lower states, respectively, and the values of the coefficients depend on the atomic masses, normal frequencies, force constances, and molecular dimensions. Two special cases which occur when the three atoms become equal and when the three atoms lie along a straight line are also considered. A wave mechanical treatment is outlined. It is found that for a triangular model the integrals, which measure the transition probabilities, corresponding to the $(v_3', 0)$ transitions when v_3' is an odd integer all vanish, and that for a linear model, in addition to these, all integrals pertaining to the $(v_2', 0)$ transitions when v_2' is an odd integer become zero. These results are, however, not to be interpreted as selection rules; they are simply consequences of the assumption of particular force fields. The results have been discussed in connection with the band intensities of ClO_2. It is shown that a knowledge of the structure of the excited molecule is essential to test quantitatively the results of the present work. AUTHOR.

4531. Mass Ratios of the Lithium Isotopes from the Spectrum of Li_2. A. McKellar. *Phys. Rev.* 44. *pp.* 155–164, *Aug.* 1, 1933.—Various members of the lithium blue-green absorption bands (both $Li^7\,Li^7$ and $Li^7\,Li^6$ systems) are analysed from spectrograms obtained with the 2nd order of a 21ft. grating. Values of ΔG_v are calculated by least squares and from them are deduced the vibrational constants of the two systems. The isotopic mass coefficient $\rho = (\mu/\mu^i)^{\frac{1}{2}} = w_e^i/w_e$ is calculated for both upper and lower states. For the $^1\Sigma$ state $\rho = 1{\cdot}04141 \pm 0{\cdot}00008$, for the $^1\Pi$ state $\rho = 1{\cdot}0411 \pm 0{\cdot}00002$. These results give a higher isotopic mass ratio Li^7/Li^6 than do the mass spectrograph results. From rotational term differences values of B_v are computed for the two systems by least squares. From the relation $B_e^i/B_e = \rho^2$ values of ρ are obtained which agree with the more accurate results obtained from the vibrational constants. The Λ-doubling for the two lowest vibrational levels of the $^1\Pi$ state is investigated and found to be sensibly equal for the main and isotope systems. No measurable electronic isotope effect is found. A. H.

4532. Continuous Gas Spectra. Part II. W. Finkelnburg. *Phys. Zeits.* 34. *pp.* 529–560, *July* 15, 1933.—In the first section of this paper [see Abstract 2179 (1930)], the principal facts concerning continuous gas spectra were described. In the present section the underlying theory which has recently been developed is considered with reference to several particular cases. The Bibliography has been brought up to date, and includes a total of 588 references. F. S.

4533. Intensity of the Radiation from Uniform Columns in Discharge-Tubes. J. S. Townsend and E. W. Townsend. *Phil. Mag.* 16. *pp.* 313–324, *Aug.*, 1933.—The intensity of radiation is determined in absolute units from a uniform column, and the amount of energy radiated from the gas is compared with the amount required to maintain the discharge. The electric force is measured by means of a cylindrical calorimeter round the discharge tube with a steady flow of water. Discharge tubes of various sizes containing neon or helium at different pressures are used. N. M. B.

4534. Absorption and Fluorescence Spectra of the Acid Sulphates of Quinine and Its Derivatives. L. J. Heidt and G. S. Forbes. *Am. Chem. Soc., J.* 55. *pp.* 2701–2709, *July*, 1933.—The absorption spectra (20,000–45,000 cm^{-1}.) of the bisulphates of quinine and of ten of its derivatives are displaced by about 200 cm^{-1}. towards smaller wave-numbers when 0·9-molar sulphuric acid is substituted for water as solvent. Increase of the size of the group attached to postion 6 of the quinoline nucleus produces a similar shift and a broadening of the absorption maxima.

The fluorescence spectra of aqueous and dilute sulphuric acid solutions excited by radiation of wave-length 3660 Å are practically identical for all the substances examined ; there is no evidence of structure. The results afford a partial explanation of the low values of the quantum yield observed in the photochemical reduction of chromate by quinine and its derivatives.
H. F. G.

4535. Precision of the Measurement of the lo Surdo Stark Effect Patterns. Y. Ishida and T. Tamura. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 437. *pp.* 158–177, *July,* 1933. *In English.*—The main source of error in the Stark effect method of lo Surdo lies in the inaccuracy of the measurements upon the patterns on the spectrogram. The chief factors involved are the so-called "chromatic variation" of the optical system of the spectrograph and the inclination of the spectrum lines. Methods are described for correcting for these factors. A discussion is also given of the effect of the variation of field strength with kathode distance upon the precision of the method. L. A. W.

4536. Treatment of the Stark Effect by the Methods of the Perturbation Theory. W. v. Koppenfels. *Zeits. f. Physik,* 84. 11–12. *pp.* 694–700, *Aug.* 21, 1933.—Mathematical. Gives the solution of the algebraic equation for the proper value perturbations of the first order.
L. A. W.

4537. Pressure Effects in the Spectra Xe I and Xe II. J. F. Heard. *Phys. Soc., Proc.* 45. *pp.* 734–739 ; *Disc.,* 740, *Sept* 1, 1933.—The first and second spectra of xenon have been examined for pressure effects. At high pressure, lines of the Xe I spectrum show broadenings which correspond qualitatively to their respective Stark effects. This points to the existence of strong interionic electric fields within the discharge. Many pressure displacements in the Xe II spectrum are also found, and it is suggested that these too have their origin in interionic fields.
AUTHORS.

4538. Rotational Raman Spectrum of O_2 at High Pressures. B. Trumpy. *Zeits. f. Physik,* 84. 5–6. *pp.* 282–288, *July* 31, 1933.—The rotational Raman spectrum of gaseous oxygen is photographed at pressures of 15, 30 and 60 atmospheres. Even at the highest pressure the rotational lines are quite distinct, though somewhat broader than at the lower pressures. This result is at variance with that previously reported by Bhagavantam, who found that with increase of pressure the rotational lines were spread out into a continuum at a pressure as low as 30 atmospheres. The intensities of the rotational lines at 15 atmospheres pressure are measured photometrically, and found to be in harmony with those calculated according to quantum mechanics. L. A. W.

4539. Influence of Ultra-Violet Absorption on the Relative Intensities of Stokes and Anti-Stokes Lines in the Raman Spectrum. S. C. Sirkar. *Indian Journ. Phys.* 8. *pp.* 67–75, *July* 15, 1933.—The value of I_{AS}/I_S in the case of the 655 line due to CS_2 excited by the line 4358 Å has been determined experimentally, using blackening-log. intensity curves obtained with the help of a standardised tungsten ribbon lamp, for comparison of intensities. It has been found that the observed value of I_{AS}/I_S definitely indicates the influence of absorption frequency on I_{AS}/I_S and gives the value 1·776 for the factor $1 + 4\nu\nu_{mn}/(\nu_{in}^2 - \nu^2)$ in the theoretical expression for I_{AS}/I_S given by Placzek. AUTHOR.

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4540. Raman Spectrum of Calcium Nitrate. E. Bauer, M. Magat and A. da Silveira. *Comptes Rendus,* 197. *pp.* 313–315, *July* 24, 1933.—The ratios of the intensities of the Raman lines 720 and 740 cm^{-1}. of NO_3' (both being compared with that of 1050^{-1}) have been determined for aqueous solutions of calcium nitrate of various concentrations, without and with addition of lithium chloride. The results do not support Grassmann's theory, but are in conformity with that of Placzek [see Abstracts 1468 (1930) and 5029 (1932)]. C. A. S.

4541. Stereo-Isomerism and Raman Effect—Raman Spectra of the Cis and Trans Isomers of Ortho-dimethyl-cyclohexane. O. Miller and L. Piaux. *Comptes Rendus,* 197. *pp.* 412–414, *July* 27, 1933.—The Raman spectra of the two isomers, separated by fractional distillation, are found to show striking differences. Of the 24 frequencies recorded for the cis-isomer and the 25 frequencies recorded for the trans-isomer only five are common to both. The completeness of the separation is indicated by the fact that even the strong lines characteristic of the one isomer are completely absent in the case of the other. The total absence of lines in the region $\Delta\nu = 1600$–1700 cm^{-1}. provides evidence that the isomers are free from aromatic impurities. Comparison of the results with those previously published for dimethyl-cyclohexane (*i.e.,* for a mixture of cis and trans) indicates that the Raman effect of the mixture is a superposition of the effects of the two isomers. L. A. W.

4542. Investigations in the Schumann Region. Part I. Schumann Spectrograph for Precision Measurements. H. Hese. *Zeits. f. Physik,* 81. 11–12. *pp.* 745–751, *April* 18, 1933.—The construction and manipulation of a precision vacuum spectrograph for the Schumann region is described. Several excellent photographs of parts of the apparatus are included. With this spectrograph it has been possible to photograph thirty spectra without disturbing the vacuum. The adjustment and manipulation of the plates are effected by a new kind of vacuum winch. The dispersion at 1854 Å is 8 Å/mm. and the resolving power is approximately 30,200 in this region. A photograph of the aluminium spectrum between 2300 and 1670 Å is reproduced. An apparatus for photographing absorption spectra (using an absorption cell and continuous light source) is described. W. R. A.

4543. Investigations in the Schumann Region. Part II. Simple Fluorite Spectrograph and its Use in Absorption Photographs. A. Rose. *Zeits. f. Physik,* 81. 11–12. *pp.* 751–763, *April* 18, 1933.—The construction of a spectrograph is described with photographic illustrations, Using plates 4½ × 6 cm. 10 spectra can be photographed on the same plate between 2050 and 1250 Å. The ultra-violet transmissivity of B_2O_3 and the absorption of oxygen, methane, acetylene and benzene have been investigated. W. R. A.

4544. Aberrations of the Concave Grating at Large Angles of Incidence. I. S. Bowen. *J.O.S.A.* 23. *pp.* 313–315, *Sept.,* 1933.—Mack, Stehn and Edlén have treated the aberrations of a concave grating at large angles of incidence for the case in which both slit and plate are on the Rowland circle. The present paper shows that, by allowing minor departures from this position, it is possible to reduce the aberration to one-fourth of the value found by them. This increases the optimum grating size and maximum resolving power by a factor of $2^{\frac{1}{2}}$. Certain conditions are discussed under which an even greater increase in the size of the grating is desirable. **Author.**

See also Abstracts 4466, 4474, 4475, 4490, 4678, 4689.

VISION.

4545. Visibility of Objects in a Searchlight Beam. W. M. Hampton. *Phys. Soc., Proc.* 45. *pp.* 663–671; *Disc.,* 671–672, *Sept.* 1, 1933.—The paper is almost entirely mathematical and calculates the effect on the visibility of an object illuminated by a projector, of the scattering and absorption of the light by the atmosphere. The discussion is divided into three parts dealing separately with the light reflected by the object from the incident beam and with the brightness of the atmospheric background due to scattered light, and of the conditions of visibility as functions of the two previous quantities. Numerical solutions of the equations are given and range curves are drawn for objects of different sizes and different reflecting powers and for sources of varying intensity. **Author.**

4546. Effect of Intensity of Illumination on the Near Point of Vision and a Comparison of the Effect for Presbyopic and Non-Presbyopic Eyes. C. E. Ferree and G. Rand. *Am. Illum. Eng. Soc., Trans.* 28. *pp.* 590–611, *July,* 1933.—In the normal eye, increase of intensity of illumination plays an important part in such ocular functions as acuity and speed of discrimination. This is still more noticeable in the early stages of presbyopia and may be used to defer the need for reading spectacles, since the near point is at the normal distance from the eye, when the intensity of the light is of the correct magnitude. Tests are made on normal eyes for people of ages 20 to 41 years and tables and graphs are given to show the connection between light intensity and the near point of vision. In all cases unless there is some special contra-indication the powers of vision are greatly improved by increase of intensity of light as the powers of the eye fail with the years. H. M. B.

4547. Influence of Chromatic Aberration of the Eye on Visual Acuity. W. de Groot and G. Holst. *Physica,* 13*e.* 7. *pp.* 231–235, 1933.—The influence of the chromatic aberration of the eye on visual acuity is demonstrated with two lightboxes provided with opal glass, the one containing a sodium lamp, the other a discharge in zinc-vapour. The spectrum of the latter chiefly contains a red (singlet) line (λ 6362) and a blue triplet (λ 4810, 4722, 4680). Small diaphragms, cut out in black paper and viewed against the *Zn*-source, appear lined with red or blue, according to the state of accommodation of the eye. With a sodium source these phenomena are absent. It is pointed out that the spectral emission curve of tungsten at 2500—3000° K, in combination with the Purkinje effect, causes similar effects especially at low illumination intensities, which is important for the problem of highway-illumination. **Authors.**

X-RAYS.

4548. Influence of Temperature on the Scattering of X-Rays by CCl_4. W. van der Grinten. *Phys. Zeits.* 34. *pp.* 609–618, *Aug.* 15, 1933.—An arrangement is described by which it is possible to obtain X-ray diffraction photographs of gases at high temperatures. Photometer records are obtained from diffraction photographs of CCl_4 taken at 100°C.

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and 350°C. When strictly monochromatic rays are used a satisfactory agreement is obtained between theory and experiment. The influence of atomic vibration on the diffraction of X-rays by gases and crystals is discussed. J. T.

4549. Determination of the J-Discontinuity by a Condition of Matter. C. G. Barkla and J. S. Kay. *Phil. Mag.* 16. *pp.* 457–472, *Aug.*, 1933. *Supplement.*—Experiments are described which show that an absorption discontinuity is dependent on some state of the particular substance used to scatter and transmit the X-radiation employed. It is also found that certain voltages are more favourable than others to the occurrence of the discontinuities, other conditions remaining unchanged. A. H.

4550. Magnitude of the L-Absorption Discontinuities. I. Backhurst. *Phil. Mag.* 16. *pp.* 310–313, *Aug.*, 1933.—Relations between the L-absorption jumps and the atomic energy levels previously proposed [see Abstract 2207 (1929)] are tested with data since available for several elements, but results are inconclusive. N. M. B.

4551. Absorptions in Ultra-Soft X-Rays. J. A. Prins and A. J. Takens. *Zeits. f. Physik,* 84. 1–2. *pp.* 65–74, *July* 17, 1933.—Some $L_{II, III}$ and $M_{IV, V}$ borders were photographed by the plane grating method. The level-values deduced agree well with those obtained in harder regions; with exceptions in the case of the $M_{IV, V}$ level in 52 Sn, 48 Cd and 47 Ag. The weakening is in the same sense and is of the same order of magnitude as was previously observed in the elements 74 W to 90 Th. [See Abstract 3065 (1933).] A. D.

4552. X-Ray Absorption Edges of Titanium in Titanium Compounds and the Constitution of Ilmenite. L. v. Hámos and W. Stscherbina. *Göttingen Nachrichten, Math. Phys. Klasse,* 2. *pp.* 232–234, 1933.—Measurements, with description of apparatus, are given for metallic titanium and for titanium in TiO_2, $MgTiO_3$, Ti_2O_3 and ilmenite ($TeTiO_3$). In the latter substance the titanium gives values corresponding to a tetravalent behaviour, and consequently the constitution of ilmenite must be $\overset{2+}{Fe}\,\overset{4+}{Ti}\,O_3$ and not $\overset{3+}{Fe}\,\overset{3+}{Ti}\,O_3$. Both formulæ were possible from chemical considerations. H. H. Ho.

4553. Ionisation of Light Gases by X-Rays. Parts I and II. W. R. Harper. *Roy. Soc., Proc.* 141. *pp.* 669–696, *Sept.* 1, 1933.—An ionisation chamber has been designed to measure only ionisation originating in the contained gas. The production of homogeneous X-rays of wave-length 1·5 Å is also described and the technique is applied to a determination of the magnitude of the ionisation in hydrogen produced by recoil electrons liberated by homogeneous X-rays. The experimental ratio of the ionisation in hydrogen to that in air, produced by an X-ray beam of wave-length 0·5 Å is 0·00522. This agrees with the ratio calculated using Dirac's theory of recoil scattering. J. E. R. C.

4554. Solarisation of Glass by Soft X-Rays. H. Kersten and C. H. Dwight. *J. Chem. Phys.* 1. *pp.* 627–629, *Sept.*, 1933.—Window glass was solarised (coloured brown) with X-rays whose wave-lengths were principally those of the *K* lines of copper (1·54 and 1·38A). The relative amount of light transmitted by the solarised, with respect to that transmitted by the unsolarised, part of the glass was measured with the aid of a Weston Photronic cell. The effect of X-ray tube current, voltage, time of exposure and the tendency of the solarisation to fade with time, at several temperatures, were investigated. AUTHORS.

4555. Accurate Determination of the Refractive Index of X-Rays. S. Hertzrücken and K. Kotlarewskaja. *Phys. Zeits. d. Sowjetunion*, 4. 1. *pp.* 50–56, 1933. *In German.*—An experiment is described by which the refractive index of X-rays in quartz is determined by means of total reflection. From the results a value of λ for Cu K_α is determined which does not differ by more than 0·25% from values obtained by other methods. H. M. B.

4556. X-Ray Line Intensities and Kathode-Ray Retardation in Thick Targets of Silver. D. L. Webster, W. W. Hansen and F. B. Duveneck. *Phys. Rev.* 44. *pp.* 258–264, *Aug.* 15, 1933.—K-line intensities from thick silver targets have been measured in arbitrary units for voltages up to 180 kV, with emergence angles from 1 to 25°. A practical use of these data is the determination of the voltage which will give the maximum efficiency of line emission at any emergence angle. At 1° the best voltage is 70 kV but at 25° it is well above 180 kV. These data are also used in conjunction with data on thin targets to get information as to the retardation of kathode rays in silver. For this purpose the thick-target data are corrected to eliminate the effects of target absorption, indirect production of line rays through fluorescence and loss of kathode rays by rediffusion. The loss of energy per unit distance along the path of a kathode ray varies as the $-1{\cdot}4$ power of the speed, just as it does in light elements according to more direct evidence collected by E. J. Williams. [See Abstract 2465 (1932).] AUTHORS.

4557. Excitation of X-Ray Lines of the Second Kind. D. Coster and W. J. Thijssen. *Zeits. f. Physik*, 84. 11–12. *pp.* 686–693, *Aug.* 21, 1933.—Experiments are described for the determination of the excitation voltage of the $K\alpha_{3,4}$ line of sulphur. The spectra are photographed and the line intensities deduced from photometer curves. The voltages employed are measured from the readings of a milliameter calibrated by means of the Duane-Hunt limit. The excitation voltage found is 2700 ± 25 volts, which corresponds to a KL-excitation. L. A. W.

4558. Wave-Length Determinations in the Very Soft X-Ray Region. F. C. Chalklin and L. P. Chalklin. *Phil. Mag.* 16. *pp.* 363–389, *Aug.*, 1933. *Supplement.*—A vacuum spectrograph of the Thibaud type has been designed with the optical system as a separate unit. Wave-lengths were determined by reference to the CuL_α (13·306 Å) line, the plates being calibrated empirically, using five orders of this line with a strong molybdenum line as a substandard. Superimposed spectra of different elements were obtained by sputtering on to the antikathode. A number of lines of Mo, Rh, Pd, Ag, W, Ta and Pt have been measured.
J. E. R. C.

4559. Studies in the Extreme Ultra-Violet and the Very Soft X-Ray Region. Siegbahn. *Phys. Soc., Proc.* 45. *pp.* 689–698, *Sept.* 1, 1933.—A description is given of recent work at Upsala on spectra of the very soft X-ray and extreme ultra-violet region. Specially ruled gratings used at grating incidence are employed. Spectrograms illustrating the results obtained are given. It is hoped that the absolute determination

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of X-ray wave-lengths will be greatly facilitated by means of the technique developed ; considerable advances are also anticipated in the study of the structure of X-ray lines. The X-ray series are extended and a large number of hitherto unknown lines have been found to date. The study of X-ray absorption spectra is also considered in view of the new technique described.
A. H.

4560. Structure of K-Radiation from N, C, B and Be. M. Morand and A. Hautot. *Comptes Rendus*, 197. *pp.* 520–522, *Aug.* 21, 1933.—The structure of the K-radiation from N, C, B and Be has been investigated, and, while definite evidence of complexity is found only in the case of C, it is suspected in the case of N and O. This is in accord with the theoretical predictions of Hautot. J. E. R. C.

4561. Fine Structure in the K X-Ray Absorption Spectrum of Bromine. S. T. Stephenson. *Phys. Rev.* 44. *pp.* 349–352, *Sept.* 1, 1933.—The existence of an extended Kronig type fine structure in the K absorption edge of bromine is established by the double crystal ionisation spectrometer method. This fine structure as obtained with partially polarised X-rays and a single crystal absorber is very pronounced and some evidence has been found of a smoothing out and shifting of the structure for orientations of the crystal absorber in which the most probable direction of ejection of electrons is not perpendicular to an important plane in the crystal. There is some indication that the structure is less pronounced for unpolarised X-rays. The results follow from Kronig's theory of extended fine structure and quantitative agreement with the theory is obtained when comparison is made with results obtained (photographically) by others. A value for the side of a unit cube of KBr is given. AUTHOR.

4562. Recording Photodensitometer for X-Ray Photographs. W. O. Milligan. *Rev. Sci. Instruments*, 4. *p.* 496, *Sept.*, 1933.—A simple densitometer is described, which is designed to measure the standard X-ray pattern obtained with the General Electric apparatus. A Weston Photronic cell is used and the X-ray film and recording paper are both attached to the same drum, so that the speed of rotation need not be constant. This, however, involves sacrificing the magnification of the record. J. T.

4563. L-Series of Molybdenum and Silver. P. Haglund. *Zeits. f. Physik*, 84. 3–4. *pp.* 248–259, *July* 26, 1933.—A new vacuum tube spectrometer is described which is a development of the earlier tube spectrometer of Siegbahn, using two X-ray sources, one for the reference line and one for the line to be measured. The apparatus described involves rotating only the crystal between the exposure for the reference line and that for the unknown line. New measurements upon the following lines are described : 42MoLα_1, β, 47AgLα_1, α_2, β_1, β_2 and γ_1. J. E. R. C.

4564. Weak Lines in K-Spectra. E. Carlsson. *Zeits. f. Physik*, 84. 1–2. *pp.* 119–130, *July* 17, 1933.—A spectrograph is described with X-ray tube for cylindrical curved crystal. Measurements were made of weak lines Kβ_4, β_5, β_6 and β_7 for the elements Mo, Nb (β_4 only), Zr, Y, Sr and the wave-lengths ascertained. Indications were found of a transition K to M_1. The quadripolar radiation theory furnishes an explanation. [See Abstracts 1926 and 1929 (1933.] A. D.

4565. Bending of Crystals and Focussing Effect in X-Ray Spectroscopy. E. Carlsson. *Zeits. f. Physik*, 84. 11–12. *pp.* 801–810, *Aug.* 20, 1933.—If, on the bending of an elastic crystal to a circulo-cylindrical form, the atomic grating is continuously deformed, then, on the use of the crystal as a selective focussing grating for X-rays passing through, the resultant variation of the grating constant effects a special focussing. In the most favourable cases the focussing effect is ideal, apart from the broadening towards the opening, which broadening is, in the ordinary cases in spectroscopy, vanishingly small in comparison with the natural breadth of the lines. The broadening calculated by Cauchois must fall off on account of the thickness of the crystal layer. The breadths of the first four orders for Mo$K\alpha_1$ taken photographi-photometrically by this method, using gypsum as the flexible crystal, are such as to show that the author's methods of calculation are well grounded. [See preceding Abstract.]

A. D.

4566. X-Ray Spectroscopy with Curved Crystalline Reflectors. L. v. Hámos. *Ann. d. Physik*, 17. 6. *pp.* 716–724, *July*, 1933.—The geometry of the Bragg reflections at a cylindrically curved piece of crystalline material is investigated and errors due to astigmatism are calculated. The dispersion and spectral resolution are discussed. The intensities of the spectra are compared with those obtained by means of a plane crystal spectrometer. The author compares his method with the slitless spectrometers of Johann and Cauchois.

J. E. R. C.

4567. High Vacuum Spectrograph for Chemical Analysis with X-Rays. E. Alexander. *Zeits. f. Physik*, 83. 7–8. *pp.* 512–516, *June* 28, 1933.—A description is given of a spectrograph which has two dispersions with 8 and 13 cm. film radius and renders possible the taking of pictures up to a range of angle of 120°. By a suitable arrangement complete uniformity of illumination can be obtained.

J. J. S.

4568. High Vacuum X-Ray Spectrometer. A. Sandström. *Zeits. f. Physik*, 84. 9–10. *pp.* 541–556, *Aug.* 12, 1933.—A high-vacuum X-ray focussing spectrometer is described. It is based on Johann's method [see Abstract 3118 (1931)], in which a concave crystal is employed, and is so arranged that photographs over a large spectral range are obtained without any motion of the parts of the spectrometer during an exposure. The line breadth is limited geometrically and the influence of this on the intensity distribution is discussed. Results obtained for emission and absorption spectra are given, together with photometer curves of some of the photographs.

J. T.

See also Abstracts 4340, 4623.

HEAT.

CALORIMETRY.

4569. Molecular Heats of Organic Liquids. N. de Kollosowsky and W. W. Udowenko. *Comptes Rendus,* 197. *pp.* 519–520, *Aug.* 21, 1933.—The specific heats of eighteen organic liquids have been measured at temperatures from 14 to 24° C, using an electrical differential calorimeter. It is pointed out that they furnish information on $\delta S/\delta t$, where S is the entropy. J. H. A.

4570. Specific Heat of Copper from − 78° to 0° C. S. M. Dockerty. *Canad. J. of Research,* 9. *pp.* 84–93, *July,* 1933.—This paper is a continuation of recent work [see Abstract 2469 (1933)] on the specific heats of tungsten, molybdenum, and copper from 0° to 500° C. The "method of electrical heating" and adiabatic calorimetry have been extended to determine the specific heat of copper from − 78° to 0° C. The equation previously given for the specific heat of copper contained only the first two terms of the Debye expansion and was found not to hold below − 30° C. The following equation containing four terms of the Debye expansion fits the experimental curve from − 78° to 500° C. with a maximum deviation of only about 0·05 %,

$$C_p = \cdot 3889 + 5\cdot 65 \times 10^{-5}T - \frac{2000}{T^2}\left(1 - \frac{321^2}{28T^2} + \frac{321^4}{910T^4}\right),$$

where the units are joules per gram per ° K. The constants of this equation were determined empirically and their close relation to theoretically expected values has been discussed. AUTHOR.

4571. Thermal Effect Produced by the Exposure of Gold to Saturated Water Vapour. F. Barry and E. P. Barrett.—*Am. Chem. Soc., J.* 55. *pp.* 3088–3098, *Aug.,* 1933.—The presence of water vapour in the insulating air-gap has been found to be a source of error in precise adiabatic calorimetry. The effect, which was first reported in an earlier paper [see Abstract 1884 (1922)] and was tentatively attributed to adsorption of water vapour by the gold-plated surface of the calorimeter, is certainly not adsorption in the usual sense and still awaits a full explanation. Using a disc of solid gold supported within the calorimeter, precise measurements of the heat liberated on exposure of the gold to water vapour and the accompanying change in weight have been made under similar conditions of experiment. The quantities could be measured to ± 0·0005 gm. cal. and ± 0·0001 gm. respectively. Both the heat liberated on exposure of the gold to water vapour and the quantity of water adsorbed decrease exponentially with time. The total heat evolved is 0·0397 cal. per sq. cm., and the amount of water gained $24\cdot 76 \times 10^{-6}$ gm. per sq. cm. It is calculated that the heat developed decreases from an initial value of 7570 cal. per gm. to a final value of 560 cal. per gm. which is satisfactory in that it approximates to the heat of vaporisation of water. R. W. P.

4572. Griffin-Sutton Combustion Bomb for Fuels. T. Carlton-Sutton. *Journ. Sci. Instruments,* 10. *pp.* 286–288, *Sept.,* 1933.—A description of the novel features of a combustion bomb which can be closed by hand, and which attains an accuracy of 0·1 % on the calorific value and 0·05 and 0·1 % respectively on the carbon and on the sulphur contents. AUTHOR.

See also Abstracts 4569, 4589, 4590, 4591.

CONDUCTION.

4573. Thermal Conductivity of Colloid Systems. S. Bresler. *Kolloid Zeits.* 64. *pp.* 178–181, *Aug.*, 1933.—The thermal conductivity of colloidal systems of a high degree of dispersion is shown to be conditioned by the dispersion of the Debye heat waves by the boundaries of the two phases of the system. Approximate calculation of the dispersion of the Debye waves in colloidal systems indicates the correct order of magnitude of the thermal conductivity of highly polymeric compounds, glasses and liquids. T. H. P.

4574. Thermal Conductivity of Acheson Graphite. A. P. Crary. *Physics,* 4. *pp.* 332–333, *Sept.*, 1933.—Thermal conductivity of Acheson graphite is reported for the temperature range − 150° C. to + 700° C. Cylindrical blocks of the material were placed above and below a flat electric heater and lateral losses balanced out by auxiliary coils wound on the surface of the sample. The results show a continual decrease in thermal conductivity with temperature over the entire range. The law, $k/a\mathrm{C} = \mathrm{A}/\mathrm{T} + \mathrm{B}$, proposed by Bidwell for certain other materials is found to hold accurately for graphite. AUTHOR.

CONVECTION.

4575. Convection of Heat from Plates and Cylinders. N. A. V. Piercy and H. F. Winny. *Phil. Mag.* 16. *pp.* 390–408, *Aug.*, 1933. *Supplement.*—The solution is a theoretical one, restricted to the case of stream-line flow over a plate or across a cylinder of circular or stream-line form. The boundary conditions taken are (1) that the temperatures of the fluid and solid are equal where the two are in contact; (2) that the temperature of the solid varies according to the law $\theta = \theta_0 x^n$ where x is the distance measured along the direction of flow of the fluid, θ_0 and n being constants. In the particular case $n = 0$ (*i.e.*, $\theta =$ constant) the equations are solved for the two extreme cases nl small and nl large, where l is the length of the solid and $n = \mathrm{U}c/2\mathrm{K}$, U being the fluid velocity, and K/c the thermal diffusivity of the fluid. In other cases, only large values of nl are considered. In an Appendix the theory is compared with experimental results due to various authors. J. H. A.

DILATATION.

4576. Expansion of Boron. E. Dupuy and L. Hackspill. *Comptes Rendus,* 197. *pp.* 229–230, *July* 17, 1933.—The thermal expansion of boron is measured over the range 20° to 750° C. in an atmosphere of H_2. It is found to follow an approximately linear law, and the mean coefficient is given as $8{\cdot}3 \times 10^{-6}$, the possible error being about 3 %. R. W. P.

4577. Thermal Expansion of Zinc by X-Ray Method. E. A. Owen and J. Iball. *Phil. Mag.* 16. *pp.* 479–488, *Aug.*, 1933. *Supplement.*—The parameter of zinc has been measured at various temperatures ranging from 20° C. to 400° C. It is found that the crystal structure remains close-packed hexagonal even at the highest temperature. This is taken as evidence that no allotropic modification of zinc exists up to this

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temperature. From the values of the parameter and axial ratio, the mean thermal coefficient of linear expansion along and at right angles to the hexagonal axis, and the mean volume coefficient, are calculated for different ranges of temperature. AUTHORS.

EVAPORATION.

4578. Theory of the Psychrometer. Part II. Effect of Velocity. J. H. Arnold. *Physics*, 4. *pp.* 334–340, *Sept.*, 1933.—The psychrometric constant ψ, defined as the ratio of A (corrected for radiation) to the A predicted by the convection theory, is shown to be a function of velocity. At infinite velocity, the new equation reduces to that of August ($\psi = 1$); at zero velocity, to the result obtained by Maxwell, $\psi = K/D$. An improved method of obtaining the true wet-bulb temperature is given, together with values of ψ, accurate to about 1 % for toluene, chlorbenzene and xylene. Straight lines are obtained when ψ for the latter two liquids against ψ for toluene at the same velocity. The theoretical psychrometric line for water is found; it is shown from theory that the line uncorrected for radiation possesses a stationary minimum value at velocities between 1000 and 10,000 ft./min., the radiation error just balancing the deviation from the August theory. In this range A is constant at 630×10^{-6}, while at lower velocities it varies rapidly because of the change in the radiation error. For accurately reproducible results, the air velocity must be maintained at 1000 ft./min. or more. [For Part I see Abstract 3679 (1933).] AUTHOR.

4579. Surface Energy and Evaporation of Droplets. Dorothy J. Woodland and E. Mack, Jr. *Am. Chem. Soc., J.* 55. *pp.* 3149–3161, *Aug.*, 1933.—With the object of testing the validity of the Kelvin equation connecting vapour pressure, surface energy and curvature of the surface, the rate of evaporation of droplets of *n*-butyl tartrate and of *n*-butyl phthalate, of radius 2 to $0{\cdot}7\mu$, is studied in a Millikan oil-drop apparatus. Assuming the rate of evaporation to be proportional to the radius the values obtained for the surface energy of the droplets are 50 to 100 times greater than the flat surface energy. This anomaly can, however, be avoided by employing the Langmuir diffusion equation, and assuming the effective radius of the droplet to include the thickness of the surrounding film of saturated vapour. This was found to be of the order of $0{\cdot}6\mu$. It is suggested that Shereshefsky's conclusion [see Abstract 882 (1929)] that the surface energy increases at a concave liquid surface may not necessarily follow since the apparent lowering of the vapour pressure in his experiments may be satisfactorily accounted for on kinetic grounds. Measurements of surface tension of water in graded capillaries down to $6{\cdot}7\mu$ radius fail to show any deviation from the value for a flat surface. R. W. P.

4580. Volatilisation from Potassium Oxide-Silica Glasses. E. Preston and W. E. S. Turner. *Soc. Glass Technol., J.* 17. *pp.* 122–144, *June*, 1933.—The volatilisation of K_2O from potash-silica glasses of composition ranging from 10·12 to 49·32% K_2O has been studied at temperatures varying from 1100° C. to 1400 or 1450° C. The rate of volatilisation at constant temperature is represented by the formula $\log \{(A - 2x)/A\} = kt$ where A is the amount of K_2O initially present and x the loss after t hours. A linear relation exists between the logarithm of the initial rate of loss and the inverse of the absolute temperature.

Experiments on the two glasses richest in K_2O show the rate of volatilisation to be proportional to the vapour tension of the volatilising constituent. Evidence is obtained for the existence in the molten glasses of the compound K_2O, 4 SiO_2, and possibly K_2O, 2 SiO_2, at the appropriate concentration. R. W. P.

See also Abstract 4596.

TEMPERATURE, MEASUREMENT OF.

4581. International Comparison of Temperature Scales Between 660° and 1063°C. W. F. Roeser, F. H. Schofield and H. A. Moser. *Bureau of Standards, J. of Research,* 11. *pp.* 1–6, *July,* 1933.—This paper reports an intercomparison of the temperature scales (in the range 660° to 1063° C.) in use at the National Physical Laboratory, the Physikalisch-Technische Reichsanstalt, and the Bureau of Standards since 1927. It is shown that the methods used in realising the International Temperature Scale have yielded results differing by as much as 0·7° C. at 850° C. due primarily to a difference of 0·4° C. at the freezing point of silver, one of the basic fixed points of the International Temperature Scale. After exchanging samples of silver and thermocouples the various scales have been brought into agreement, within 0·1° C., at all points in the range covered. AUTHORS.

4582. Heating of a Cylindrical Body by Rapid Movement through the Air. E. Brun. *Comptes Rendus,* 196. *pp.* 1960–1962, *June* 26, 1933.—The apparatus previously described [see Abstract 2480 (1932)] has been considerably improved. For brass cylinders of 2·4 cm. diameter moving at velocities between 35 and 70 m. per sec. the rise of temperature (°C.) is given by $(3{\cdot}12 \pm 0{\cdot}06)\ 10^{-4}v$, v being the velocity. The coefficient of thermal exchange, h, varies between 0·025 and 0·04 watt/cm.^{2}, and is related to v by the expression $h = av^n$, where n is approximately 0·8. H. F. G.

4583. Air Thermostat for Solubility Measurements. H. G. Beier and H. Brintzinger. *Kolloid Zeits.* 64. *pp.* 173–175, *Aug.,* 1933.—To avoid the inconveniences involved in the use of a water thermostat, an electrically heated air thermostat, provided with a fan, is recommended. With the apparatus described, which has been in continuous use for two years and can be employed for temperatures below that of the room, the maximum variations of the air temperature are ± 0·1° C. The consumption of current is very small. T. H. P.

See also Abstract 4340.

THERMOCHEMISTRY.

4584. Theory of Detonation. K. K. Andreew. *Phys. Zeits. d. Sowjetunion,* 4. 1. *pp.* 120–124, 1933. *In German.*—Owing to the extraordinarily quick propagation of exothermal chemical change through the mass of a condensed explosive system, the chain mechanism of the reaction must be of prime importance. The importance of the chain in detonation has been emphasised by Garner, Semenoff, Muraour and others. The author endeavours to show that the circumstances necessary for the existence of an infinitely long chain are much more favourable in the case of primary explosive substances than in secondary explosive substances. He gives a formula from which the total length of chain can be determined, and also calculates the difference between the heat of activation and the energy of a particle of the reaction product. A table is given for six explosives. It is seen that the heat of activation is approximately twice as great for secondary explosives as for primary ones. T. B.

4585. Flame Phenomena of Carbon Monoxide. A. R. J. P. Ubbelohde. *Chem. Soc., J. pp.* 972–977, *Aug.*, 1933.—In the work published on the effect of H_2 and H_2O on the combination of CO, most of the experiments have been carried out in closed vessels. The observations now recorded deal with the formation of O_3 and H_2O_2 in the open flame burning at a jet in oxygen, and with the influence of H_2 and of certain metals and salts on the luminescence in the flame. The method used in obtaining the large volumes of dry gases required is described. From the variation in the height of the flame with H_2 content, the luminescence is shown to be dependent, in a marked way, on the molar fraction of H_2 when this falls below 10^{-3}. Small concentrations of H_2 (10^{-7}) are measurable in this way. Evidence is furnished to show that the O_3 and oxides of nitrogen appearing in the combustion products of CO are formed neither by photosynthesis nor from the decomposition of H_2O_2. The effect of alkali-metal halides and Pt vapour on the luminescent combustion of CO differs in various respects from that of H_2. T. H. P.

See also Abstracts 4463, 4595.

THERMODYNAMICS.

4586. Thermodynamic Principle Governing Stationary States. B. Bružs. *Zeits. f. Elektrochem.* 39. *pp.* 642–645; *Disc. p.* 645, *July*, 1933; *Phil. Mag.* 16. *pp.* 248–263, *Aug.*, 1933.—Stationary states, as distinct from equilibrium states, occur in a system when the coordinates (in a generalised sense) are not functions of time. Thus a wire carrying electrical current is in a stationary state when it has attained its final temperature excess over its surroundings. Essentials to the existence of such a state are a difference of (generalised) potential, and a bridge along which energy can be transferred, with or without matter. In the example cited, the wire would be the bridge. The phenomena (*e.g.*, the Joule heat) are essentially irreversible, and so the second law of thermodynamics is not directly applicable. It is suggested that in all such cases, the boundary conditions at the entrance and exit of the bridge are such that no change occurs in the Helmholtz free energy of the moving component. This hypothesis is an addition to the ordinary laws of thermodynamics, just as Nernst's Heat Theorem is superposed on the other laws. Similarly, when the side-walls of the bridge are in contact with the surroundings, it is assumed that the migrating matter assumes the same potential gradient as the surroundings, and consequently that the free energy is continuous on crossing the wall. The new principle is applied to a number of examples. J. H. A.

4587. Second Law of Thermodynamics and the Relations between Parts of the World-System. M. Bronstein and L. Landau. *Phys. Zeits. d. Sowjetunion,* 4. 1. *pp.* 114–119, 1933. *In German.*—A discussion of the irreversibility of thermodynamic phenomena. This irreversibility and in general the physical difference between the two directions (past and future) can only be explained from the circumstance that regions exist in the world which do not obey the theories (classical or wave-mechanical) which lead to thermodynamics. T. B.

4588. Equation of State for Films of Molecular Thickness. J. Guastalla. *Comptes Rendus*, 197. *pp.* 307–308, *July* 24, 1933.—Continuing previous work [see Abstract 3379 (1933)], experimental results are compared with an equation of state proposed for films of molecular thickness, *viz.*: $P = A/l^5 - B/l^3 + C/l^2$. A comparison curve for oleic acid is given, and from values of A, the magnitudes of the electric moments are deduced for the molecules of a few organic materials. The coexistence of two phases in the film is discussed. J. P. A.

4589. Rotational Specific Heat of a Polyatomic Molecule for High Temperatures. Correction. Irene E. Viney. *Cambridge Phil. Soc., Proc.* 29. p. 407, *July* 30, 1933.—A correction to the asymptotic expansion for a partition function used in a previous paper [see Abstract 1553 (1933)]. Qualitatively the results of the original paper remain unaltered. G. G. S.

4590. Specific Heat of the Restricted One-Dimensional Rotator. E. Teller and K. Weigert. *Göttingen Nachrichten, Math. Phys. Klasse*, 2. *pp.* 218–231, 1933.—Eucken and Parts have recently [see Abstract 2465 (1933)] determined the specific heat of ethane up to 180° K, and have concluded that already this temperature suffices to set the methyl groups in rotation with respect to each other (free rotatability). The object of the present paper is to evaluate the amount of this relative movement with respect to the specific heat at temperatures for which kT is comparable with the energy changes which occur during the mutual rotations of the groups. H. H. Ho.

4591. Thermodynamic Theory of Liquids. N. de Kolossowsky. *Comptes Rendus*, 197. *pp.* 517–519, *Aug.* 21, 1933.—A formula for the thermodynamic potential ϕ of a liquid is the starting point, its derivative with respect to p giving the equation of state

$$J(\partial\phi/\partial p)_t = V_0/(1\text{-}kt) - mV_0 \log (n + p)/(n + 1)$$

where J is Joule's equivalent, p the pressure, V_0 the molecular volume at N.T.P., k the expansion coefficient and m, n are constants. This equation is shown to contain various empirical rules as special cases. Again, writing the latent heat of evaporation in the form: (absolute temperature) × (difference of entropy between liquid and gas), and using the theoretical expression for the last quantity, an expression for the latent heat is verified numerically in the case of benzene. J. H. A.

4592. Changes in "Solid" Gases. K. Clusius. *Zeits. f. Elektrochem.* 39. *pp.* 598–601; *Disc.*, 601, *July*, 1933.—A series of changes which are especially shown by condensed gases at low temperatures is to be explained, according to Pauling, by the increasing oscillation of the lattice components as the temperature rises, and their final breaking down of the potential boundaries and conversion into rotational movement. For discovering these changes certain methods are available, *i.e.*, a thermal method, giving a cooling curve, or better, an exact measurement of the specific heat. Optical methods can also be used. Details of experiments are given for SiH_4, PH_3, H_2S; HF, H_2O, NH_2; HCl, HBr, HI, H_2S, PH_3; CO, N_2O, and NO. Entropic data are given and values of the dipole moments. T. B.

4593. General Formula for Chemical Reactions Covering all Statistics yet Known. S. Suzuki. *Phys. Math. Soc., Japan, Proc.* 15. *pp.* 258–271, *July*, 1933. *In English.*—The equation deduced is arrived at on the basis of the following considerations. The probability of a particle entering a colony of cells of phase-volume depends on the number of the particles already present (Brillouin's statistics), and the thermodynamic probability of a gas mixture depends not only on the number of reacting molecules, but also on the atoms composing them [see Ehrenfest and Trkal, Abstract 1576 (1921)]. The equation obtained comprises the three well-known statistics of Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac, as well as other possible ones. Statistics based on the hypothesis of the existence of the upper limit of energy quantum are also developed, in particular as regards chemical combination. The main conclusion deduced is that, in general, the known relations, $pv = \frac{2}{3}$ L or $\frac{1}{3}$ L, where L is the total kinetic energy of the molecules in the gaseous system, do not hold true. T. H. P.

VAPOUR PRESSURE.

4594. Glass-Wool Cell for Measuring Aqueous Vapour Pressure. N. E. Edlefsen. *Rev. Sci. Instruments*, 4. *pp.* 345–346, *June*, 1933.—A method, based on the variation in electrical resistance of a bundle of glass wool fibres contained in a glass cell, is described for measuring aqueous vapour pressures. Using a.c., with one stage of amplification across the bridge, a change in vapour pressure of 0·01 mm. of Hg. can be measured. The instrument is calibrated in atmospheres of known humidity, and has been used for the determination of the aqueous vapour pressure in equilibrium with samples of soil. R. W. P.

4595. Chemical Potential of Salt Solutions. R. E. Gibson and L. H. Adams. *Am. Chem. Soc., J.* 55. *pp.* 2679–2695, *July*, 1933.—With the aid of a static apparatus of modified design the relative vapour pressure lowerings of concentrated solutions of lithium chloride, ammonium nitrate, potassium thiocyanate and sodium sulphate were measured at room-temperature. Various empirical equations expressing the relative vapour pressures of the solutions in terms of the concentration were examined and it was found that for these salts equations expressing log (a_1/X'_1) as a function of $X'^{3/2}_2$ were, on the whole, the simplest and fitted the data most closely. By means of these equations the difference between the chemical potential of either component in a solution of a given concentration and the chemical potential of the same component in a solution of any other concentration may be readily calculated. The convenience of the activity coefficient of the solvent (a_1/X'_1) whose logarithm is directly proportional to the chemical potential difference between solvent in the solution and solvent in an ideal solution of the same concentration, both as to ease of computation and applicability over the whole range of concentration, is emphasised. AUTHORS.

4596. Vapour Tension of BaO, SrO, and CaO and Their Mixtures Deduced from Measurements of the Rates of Evaporation. E. Preston. *Soc. Glass. Technol., J.* 17. *pp.* 118–121, *June*, 1933.—The note comments upon the measurements of the rates of evaporation of BaO, SrO, and CaO, made by A. Claassen and C. F. Veenemans [see Abstract 1567 (1933)] deduces from their data certain values of the vapour tensions of these oxides, and draws the conclusion that volatilisation losses of CaO from molten glass will be extremely small. AUTHOR.

See also Abstracts 4424, 4579, 4580.

ACOUSTICS.

4597. Free Vibrations of Conical Shell. M. J. O. Strutt. *Ann d. Physik*, 17. 7. *pp.* 729–735, *Aug.*, 1933.—The natural frequencies of a thin conical shell are calculated, assuming that only such vibrations occur as involve no expansion of the shell. In applying the results to loudspeaker cones, it is assumed that the shell is bounded at one end by a rigid lamina and is free at the other end. The transition from a cone to a cylinder is worked out, and a simplified expression is found for very high frequencies. G. E. A.

4598. Radial Vibrations of Aluminium Cones. A. T. van Urk and G. B. Hut. *Ann. d. Physik*, 17. 8. *pp.* 915–920, *Aug.*, 1933.—Strutt's formulæ [see Abstract 4181 (1933)] were tested by experiment, using cones which differed only in thickness, the thickness varying from 0·02 cm. downwards. The experimental curves of frequency and number of radial nodes exhibit a systematic difference when compared with the corresponding curves obtained by theory, and the difference does not disappear with diminishing thickness of cone. Measurements with cones of variable opening and same thickness gave confirmatory results. G. E. A.

4599. Tone Formation in Lipped Pipes. J. Zahradniček. *Phys. Zeits.* 34. *pp.* 602–604, *Aug.* 1, 1933.—An experimental study of the vortex theory of tone formation in lipped pipes of shapes shown diagrammatically in the original paper. It is established that tone formation stops either when the vortex inside or outside is disturbed and the motion changes over from a turbulent to a steady laminar flow, or when the common phase difference of the vortices is disturbed. W. H. Ge.

4600. Velocity of Sound in the Atmosphere. G. Brancato. *N. Cimento*, 10. *pp.* 169–171, *April*, 1933.—The small adiabatic oscillations of a perfect gas in a condition of isothermal equilibrium are examined theoretically without neglecting gravitation. It is found that the latter has no effect on the velocity of propagation of the disturbance. H. M. B.

4601. Absorption Coefficients of Liquids for Supersonic Vibrations. P. Biquard. *Comptes Rendus*, 197. *pp.* 309–311, *July* 24, 1933. —An improved method of determining the coefficient of absorption of supersonic vibrations is described, resulting in the expression $2\eta\omega^2/3\rho V^3 + \alpha^2 KT\omega^2/2\rho VJC^2$ for this coefficient, where η is viscosity, ω frequency, ρ density, V velocity of sound, α coefficient of expansion at constant volume, K coefficient of thermal conductivity, T absolute temperature, J mechanical equivalent of heat, and C specific heat. Applied to eight organic liquids it gives results from 6 to over 100 times less than those obtained experimentally with $\omega = 7 \cdot 9578 \times 10^6$. [See also Abstracts 3834 and 4458 (1932).] C. A. S.

4602. Principles of Acoustical Insulation. V. L. Chrisler. *Bureau of Standards. Circ. No.* 403. [12 *pp.*], 1933.—A general discussion is given of the factors which control the transmission of sound through partitions. Impact noises, and methods of insulating against them receive special mention, and attention is called to the fact that a small opening may almost completely destroy the sound insulating value of a wall.

It is shown that in the presence of noise a wall which is a poor sound insulator may appear to be fairly good. AUTHOR.

4603. Sharp Sounds and the Theory of Hearing. G. v. Békésy. *Phys. Zeits.* 34. *pp.* 577–582, *Aug.* 1, 1933.—Vibrations of the tympanum were set up by sounds made within the head by performing a single swallowing motion. The sound may occur simultaneously in both ears, but in many cases it is heard in one ear sooner than in the other. The sounds can be heard by a second person using a rubber tube, and they were recorded by an oscillograph. During the dying down, the frequency of the tympanum varies from 1500 to 1200, and the decrement may have a value from 1·1 to 1·8. The action of the basilar membrane [see Abstract 1610 (1929)] and the effect of steady sounds on the hearing of sharp sounds caused by starting a current in a telephone are investigated. G. E. A.

4604. Sound Absorption in Non-Reactive Gases. D. G. Bourgin. *Acoustical Soc. of America, J.* 5. *pp.* 57–59, *July*, 1933.—The author discusses the conclusions reached by R. Lawlor [see Abstract 3715 (1933)], *viz.*, that the gas absorption in a mixture of non-reactive gases depends linearly upon the concentration, and decides that this result is untrue. J. E. R. C.

4605. Determination of Absorption for Sound Waves Incident Obliquely. Stationary Wave Method. L. Cremer. *E.N.T.* 10. *pp.* 302–315, *July*, 1933.—The resulting sound field in front of an incompletely reflecting wall for sound waves incident obliquely was investigated. The motional amplitude was investigated by means of a Rayleigh disc and found to be somewhat complex, the paths being in general elliptical and only assuming fixed directions in certain parallel equidistant planes. Apparatus is described, using a microphone of very small dimensions, by means of which the interference field in front of reflecting walls could be plotted, thus permitting the dependence of the absorption on the angle of incidence to be determined, and this apparatus could also be used for general investigation of stationary waves in rooms. Examples are given of the application of the method for samples of materials such as celotex B, slag wool mats, etc. A. W.

4606. Musical Air Bubbles and the Sounds of Running Water. M. Minnaert. *Phil. Mag.* 16. *pp.* 235–248, *Aug.*, 1933.—Air is allowed to escape in bubbles from the orifice of a tube immersed in water, and the detachment of the bubble is accompanied by a sound of definite pitch subject to small irregular variations. On the assumption that the sound is caused by the periodic and adiabatic expansion and contraction of the bubble, the frequency N is expressed in terms of the radius r of the buble, k the ratio of the specific heats of the gas employed, and ρ the density of the liquid set in vibration by the bubble, viz., $N = \sqrt{3kp/\rho} \div 2\pi r$, where p is the pressure. The experimental results confirm the theory and show that the frequency varies inversely as the radius of the bubble and as the square root of the density of the liquid, but does not vary with change of temperature. Hydrogen gives the same result as air for the product of Nr, but butane is different, and from the result the value of k for butane is found to be 1·15. G. E. A.

See also Abstract 4696.

ELECTRICITY AND MAGNETISM.

ALTERNATING-CURRENT NETWORKS.

4607. Comparison of the Mutual-Inductance between Two Coils with the Self-Inductance of one of them. H. Mukherjee. *Indian Journ. Phys.* 8. *pp.* 1–7, *July* 15, 1933.—If, in Wheatstone's arrangement, a coil of self-inductance L, and of resistance R, shunted (if necessary) with a resistance R′, is placed in one of the arms, and another coil is placed in the galvanometer arm, the conditions of balance with A.C. are

$$PS = \frac{RR'}{R+R'}.Q \text{ and } \frac{M}{L} = \frac{Q}{P+Q}.\frac{R'}{R+R'},$$

where M is the mutual-inductance between the coils and P. Q, S have their usual significance. In order to determine the ratio M/L by this method an A.C. galvanometer of the form of a dynamometer or a wattmeter is necessary. The method is very suitable for calibrating a variable mutual-inductance. AUTHOR.

4608. Simple Frequency Bridge. R. M. Davies. *Journ. Sci. Instruments*, 10. *pp.* 274–276, *Sept.*, 1933.—It is shown that a simple modification of the well-known Hughes balance leads to a useful frequency bridge, which, under certain conditions, can be balanced by a single adjustment. The bridge was tested against a phonic motor, and the results obtained are within the limits of accuracy of the apparatus, namely 1 part in 1000. AUTHOR.

CONDUCTION AND DISCHARGE IN GASES.

4609. Corona Discharge in Noble Gases. F. M. Penning, J. Moubis and C. C. J. Addink. *Physica*, 13e. 7. *pp.* 209–224, 1933.—Continuation of previous work [see Abstract 2779 (1931)]. Details as to the characteristics of the corona discharge between concentric cylinders in neon-argon mixtures. A. D.

4610. Electrostatic Theory of the Plasma. D. Gábor. *Zeits. f. Physik*, 84. 7–8. *pp.* 474–508, *Aug.* 7, 1933.—For the kinetic of Langmuir's plasma of the luminous arc and of the isothermal plasma of the star substance the electrostatic forces between the carriers of charge are of decisive importance in an extensive region. In this paper the electrostatic forces only are taken into consideration. There is given however a general theoretical framework into which can be easily fitted the actions of the neutral particles and of the radiation which hitherto have been exclusively considered. The state of the plasma is exhibited by distribution functions which give the density and the distribution of velocity for each kind of ion as local function. J. J. S.

4611. Mechanism of Spark Discharge. A. Nikuradse. *Zeits. f. Physik*, 84. 11–12. *pp.* 701–704, *Aug.* 21, 1933.—A study was made of the breakdown voltage for a series arrangement of two insulating layers—gas and liquid—with applied potentials of short duration (10^{-8} to 10^{-7} sec.) with different electrode arrangements. Curves are given showing the breakdown voltage as a function of the thickness of the liquid layer for plane electrodes and also for point and plane electrodes, the point being in some cases positive and in others negative. It is shown that the discharge in gases at normal pressure takes the form of a fine ray of carriers. If a gas bubble is present in a liquid, breakdown occurs in this for some definite field strength and this breakdown is analogous to the introduction of a point electrode. The field concentration at the point causes ionisation of the fluid and makes possible the passage of a spark. The experimental results are in agreement with this hypothesis. A. W.

4612. Return Arc as Breakdown in Strongly Ionised Gas. G. Timoshenko. *Zeits. f. Physik*, 84. 11–12. *pp.* 783–793, *Aug.* 21, 1933. —The phenomena of the re-ignition of short a.c. arcs between metal electrodes, which can be considered as breakdown in strongly ionised gas, were investigated by means of potential measurements in the gap in passing through the null-current stage. The phenomena take place in about 50×10^{-6} sec. The potential distribution indicates the formation of a glow discharge, which precedes the new arc discharge, and the formation of a positive space charge layer at whichever electrode happens to be the kathode, so that the total potential difference at the arc electrodes during the null-current stage may be some hundreds of volts. Experiments with currents of 300 to 3000 amperes exhibit the influence of the material of the electrodes on the breakdown. A critical review is given of the most important results of other workers bearing on the theory of a.c. arc re-ignition. A. W.

4613. Electrical Diffusion of Ions in Gases of Bipolar Charge. N. Wolodkewitsch, *Zeits. f. Physik*, 84. 9·10. *pp.* 593–609, *Aug.* 12, 1933.—It is shown theoretically that for a gas carrying a homogeneous bipolar charge, the rate of change of charge density is expressed by the same formula as for a unipolar charge [see Abstract 1985 (1933)] ; also the effective mobility acquired is of the same sign in both cases. Experiments are described which support the theory. F. C. C.

4614. Mobility of Positive Ions in Gases. T. Edqvist. *Phys. Zeits.* 34. *pp.* 618–623, *Aug.* 15, 1933.—A theoretical calculation, using the formula of P. Lenard and considering the electrical force between the ion and the molecule of gas, is used to find the mobility $k \dfrac{\text{cms./sec.}}{\text{volts/cm.}}$ of a $+^{\text{ve}}$ ion in a gas at ordinary values of temperature, pressure and field strength. The results are in agreement with the most reliable experimental observations especially for monatomic positive ions but some recent large values of k, as *e.g.*, Na^+ in helium $k = 30$, have not yet been proved theoretically, and also complicated ions show rather large discrepanceis. H. M. B.

4615. Physical Processes in the Mercury Arc at Low Pressures. E. Lübcke. *Zeits. f. techn. Physik*, 14. 8. *pp.* 297–304, 1933.—A brief review of the physical processes in the Hg arc at low pressures. Probe methods give a survey of the potential gradient, the carrier current, the temperature and of the ion concentration. From these data the formation of the carrier current and the nature of the current transport, particularly in the neighbourhood of the kathode and the positive column, were considered. F. C. C.

4616. Positive Column in Hittorf Dark Space. A. Güntherschulze and H. Betz. *Zeits. f. Physik*, 84. 11–12. *pp.* 740–745, *Aug.* 21, 1933.—If the anode of a glow discharge is brought immediately over a large plane kathode, the electrons from the glow must stream back through the fall space in order to reach the anode. In this way, with a fall space of sufficient thickness, there is formed in it a characteristic luminous positive column. The appearance and character of this positive column in H_2, O_2, N_2, He, Ne and A are briefly described. Large differences are found. On the one hand the positive column in He for 3 cm. length has a p.d. of 175 volts, while for a 5·5 cm. arc in N_2 the p.d. is only 57 volts. A. W.

4617. Effect of Positive Space Charge in Collector Analysis of Discharges. R. H. Sloane and K. G. Emeléus. *Phys. Rev.* **44.** *pp.* **333–337,** *Sept.* 1, **1933.**—By use of a collector with mutually insulated sections to which different potentials could be applied, it has been shown, with a low-voltage arc in argon, that under the special conditions of short collector and small electron concentration the positive ion sheath which forms on insulating surfaces near a collector in a plasma may lead to serious misinterpretation of the characteristics of the collector. The effect is twofold, first, a general diminution in the apparent concentration of electrons in the plasma, and, second, an apparent preferential suppression of the slowest electrons. Under most working conditions, these are probably inconsiderable at low pressure but perhaps important at a pressure of a few mm. and higher. The collector characteristics obtained have been analysed for Maxwellian distributions and by a method in which no initial assumption is made concerning the energy distribution other than that it is isotropic. A formula is given to facilitate double differentiation in the latter case. AUTHORS.

4618. Formation of Negative Ions in Mercury Vapour. U. Stille. *Ann. d. Physik,* **17. 6.** *pp.* **635–653,** *July,* **1933.**—It has often been stated that when mercury atoms are excited negative ions are formed. This has been studied in great detail and with strictly controlled conditions. It is found no negative ions are formed in the discharge in mercury vapour. if this is perfectly pure. But with the slightest trace of water vapour present values for e/m are found corresponding to negative Hg ions. Often too the ions appear to be Hg .H^-. J. E.

4619. Ionisation Potential and Formation of the Hydrogen Molecule. J. Savard. *Comptes Rendus,* **197.** *pp.* **397–399,** *July* **31, 1933.**—Comparison of the total energies of H_2^+ and H_2 as calculated by Hylleraas [see Abstract 337 (1932)] with the ionisation potentials as experimentally determined shows that the energy of formation of the normal molecule from normal atoms is double the difference between the ionisation potentials of the molecule and atom. C. A. S.

4620. Optical and Ultra-Ionisation Potentials of Mercury. R. G. Loyarte and Margarita H. de Bose. *Phys. Zeits.* **34.** *pp.* **589–592,** *Aug.* 1, **1933.**—Kallmann and Rosen [see Abstract 4291 (1931)] have recorded several so called ultra-ionisation potentials of Hg, whose values have in fact been already noted by the first-named author. A table of the so-far recorded excitation potentials of Hg is given with authors and dates showing the priority of Loyarte to some values. A number of new measurements have been made by the photoelectric method by the second author, correct to 0·01 V. An identification of the transition involved is given. Three values, 8·91, 9·01 and 9·23 do not correspond to any known transitions but the subtraction of 1·4 volts from each of the first two gives well-known transitions, while the same addition to the third gives the 10, 60 found by Lawrence and called an ultra-ionisation potential. J. E.

4621. Maintenance of a Constant Potential of about 1000 Volts by Means of a Positive Corona Discharge. Portable Apparatus for the Operation of Tube and Point Counters. G. Medicus. *Zeits. f. techn. Physik*, 14. 8. *pp.* 304–306, 1933.—From a sufficiently long discharge tube made of Geiger-Müller tube counters connected in series with a suitable high resistance (stabiliser), a source of potential can be obtained which is independent of fluctuations in the total applied potential. By changing the pressure, this stabilised potential can be altered over a range of $10^3 - 10^4$ volts. Using dry air and an out-gassed tube, the stabilised potential is practically independent of temperature change. With this stabiliser, a spark coil and a spark gap can be used as a source of potential for Geiger-Müller counters or for other work. F. C. C.

4622. Mechanism of Geiger-Müller Tube Counters. W. Christoph and W. Hanle. *Phys. Zeits.* 34. *pp.* 641–645, *Aug.* 15, 1933. —The variations in the discharge number of a Geiger-Müller tube counter with change of gas pressure, discharge potential and kathode material, are investigated. The effect is extraordinarily dependent upon temperature and is intimately connected with photoelectric processes. F. C. C.

4623. Combined Tesla Coil and Vacuum Tube. C. C. Lauritsen and R. Crane. *Rev. Sci. Instruments*, 4. *pp.* 497–500, *Sept.*, 1933.—An oil immersed high frequency resonance coil has been constructed and combined with a vacuum tube in such a way that none of the high voltage parts are exposed to the air. This makes a very compact apparatus, and it is not subject to corona losses. Potentials up to 750,000 volts have been produced on the inner electrode, by exciting the primary circuit with a condenser discharge. An improvement in the design is proposed, which makes use of a system of concentric shields around the inner electrode, for the purpose of distributing the potential drop in a more advantageous manner, and making it possible to go to higher voltages before cold emission occurs. Excitation of the apparatus by means of a continuous wave oscillator, and its use as a high voltage X-ray outfit for practical purposes is discussed. AUTHORS.

4624. Origin and Behaviour of Negatively Charged Metallic Particles in Electrical Discharges. K. Sommermeyer. *Phys. Zeits.* 34. *pp.* 582–589, *Aug.* 1, 1933.—Negatively charged metallic particles are produced either by evaporation of or by sputtering a metal situated in the neighbourhood of the kathode during a discharge through a rare gas, and the conditions governing their transport are examined. If rapid evaporation occurs or there is a high sputtering velocity, a considerable quantity of the metal follows the lines of force and arrives at the anode. It cannot be definitely distinguished whether negative atomic (or molecular) ions or larger charged bodies are transported but the former is considered the more probable. F. C. C.

See also Abstracts 4386, 4486, 4496, 4556, 4707.

CONDUCTION IN SOLIDS AND LIQUIDS.

4625. Influence of Surface Charges on Conductivity of Poor Conductors. A. D. Goldhammer. *Zeits. f. Physik.* 84. 3–4. *pp.* 212–217, *July* 26, 1933.—It was observed experimentally that in electrostatic measurements of the electric conductivity of poor conductors, *e.g.*, amber, surface charges influence the results to a great extent. Methods for the elimination of errors arising are discussed. W. R. A.

4626. Measurements with the Aid of Liquid Helium. Part XXII. Resistance of Metals, Alloys and Compounds. W. Meissner, H. Franz and H. Westerhoff. *Ann. d. Physik,* 17. 6. *pp.* 593–619, *July,* 1933.—The resistance-temperature curves for a number of substances are studied down to about 1·3°K. A very pure specimen of Nb, containing 0·08% O_2 and 0·02% Ta, is found to become supraconducting at 9·2°K. This is the highest transition temperature yet obtained for a pure metal. A series of Pb-As alloys are investigated and concluded to be heterogeneous mixtures as they become supraconducting at the same temperature as pure Pb. Mo-C alloys containing 42 to 58 atomic percentage of C have a common transition point of about 8·5°K, indicating the presence of an eutectic alloy for this range of composition. The resistance temperature data for 21 mixed crystals and eutectic alloys are tabulated. The following are found to become supraconducting, Ag-Tl (5·7 atomic % Tl), Cd-Pb (1 and 2·7 atomic % Pb) ; Cu-Hg (8 atomic % Hg) ; Cd-Tl (16·8 atomic % Cd). A large number of intermetallic compounds, having similar crystal structures are examined, but do not show supraconducting properties above 1·3°K. Negative results are also obtained for four arsenides, three tungsten bronzes, six selenides and two tellurides. Of ten sulphides tested only CuS is supraconducting. PbS is carefully examined and when pure and free from Pb is not supraconducting—this result is contrary to that of earlier investigators. Samples of NbO, SnO and Pb_2O are found to be supraconducting, but this is probably due to the presence of the free metals, the last mentioned oxide being a mixture of Pb and PbO. Tl_2O_3, MoO_2, Sn_2O_3 and PbO_2 do not become supraconducting. R. W. P.

4627. Self-Consistent Field for Bound Electrons: Supraconductivity. L. Brillouin. *J. de Physique et le Radium,* 4. *pp.* 333–361, *July,* 1933.—It is shown that Hartree's method of the self-consistent field can be combined with the ideas of Heitler and London, so as to utilise it for electrons bound to atoms. The method is successful when applied to metals with a crystal structure of the Bravais type, in particular to cubic face-centred or body-centred lattices. In the latter cases, for certain directions of movement of losely bound electrons, the energy curves are " humped " with secondary minima. This phenomena leads to metastable distributions of electrons at low temperature, and may assist in explaining supraconductivity. J. H. A.

4628. Theory of Supraconductivity. Part I. L. Landau. *Phys. Zeits. d. Sowjetunion,* 4. 1. *pp.* 43–49, 1933. *In German.*—The theory developed is based upon the saturation current produced inside each elementary volume of the supraconductor. A thermodynamical treatment is given, similar to that used for the elucidation of ferromagnetism. Theoretically, the magnetic moment of the saturated layer is found to be proportional to $\sqrt{(\theta-T)}$ while Leiden experiments shows a linear dependence on θ—T, where θ is the critical absolute temperature and T any absolute temperature used. H. M. B.

4629. Frequency Dependence of Supraconductivity and Ferromagnetism. R. Sänger. *Phys. Rev.* 44. *pp.* 302–307, *Aug.* 15, 1933.—An attempt is made to explain the frequency dependence of supraconductivity and ferromagnetism as a further consequence of the skin effect, assuming the existence of a surface layer which shows neither supraconductive nor ferromagnetic properties. The existence of this surface

layer may be in some way connected with the results of recent theoretical investigations on crystal structure involved in the ideas of Epstein on ferromagnetism and in Zwicky's conception of a secondary structure.
AUTHOR.

4630. Electrical Conductivity in Zinc-Cadmium and Lead-Antimony Systems. M. le Blanc and H. Schöpel. *Zeits. f. Elektrochem.* 39. *pp.* 695–701, *Aug.*, 1933.—Measurements have been made at different temperatures and with special consideration of stable equilibrium compositions. Since systems of zinc-cadmium and lead-antimony exhibit no compound formation, and only mixed crystals to a small degree, it has been necessary to establish whether retardations occurred in arriving at the stable resistances. With zinc-cadmium alloys, delay only occurred at the extreme points, *i.e.*, with about 10 atomic % Zn or Cd, but with lead-antimony alloys retardation occurred throughout the whole concentration-range. Temperature-resistance curves enabled the limits of the single phases to be determined, *viz.*, at 263° the saturation limits are 97·5 and 6 atomic % Zn for Zn-Cd alloys, and 94·2 and 1·5 atomic % Pb for Pb-Sb alloys. These results were confirmed by micrographic experiments, although no indication was given for the maximum electrical conductivity with 5 atomic % Pb. H. H. Ho.

4631. Electrical Conductivity of Cu_3Pd and Cu_3Pt Alloys. H. J. Seemann. *Zeits. f. Physik*, 84. 9–10. *pp.* 557–564, *Aug.* 12, 1933.—Measurements of the electrical resistance of Cu_3Pd and Cu_3Pt alloys show in the state of regular atomic distribution only a small increase of the falling-off of resistance at low temperatures in contrast with the state of irregular atomic distribution. These alloys differ very markedly in this respect from the Cu_3Au alloys previously examined. J. J. S.

4632. Thermo-E.M.F. and Ludwig-Soret Effect in Solid Salts and Mixed Crystals. H. Reinhold. *Zeits. f. Elektrochem.* 39. *pp.* 555–561 ; *Disc.*, 561, *July*, 1933.—In dealing with the thermo-e.m.f. and Ludwig-Soret effect their relation to the electrolytic conductivity is considered. From the conductivity formula $K_T = A.e^{-\frac{E}{RT}}$ there can be deduced the existence of the thermoelectric homogeneous effect in solid salts and of the Ludwig-Soret effect in mixed crystals. J. J. S.

4633. Electrical Conductivity and Diffusion in Non-Metallic Solids. C. Tubandt. *Zeits. f. Elektrochem.* 39. *pp.* 500–506, *July*, 1933.—Three classes of conductors are recognised, according to the relation between temperature and conductivity, *viz.*, those to which a simple exponential law is applicable, those requiring an equation of the Smekal type, and those for which the relationship is more complex. The significance of the behaviour of the members of each group is discussed. The relation between the work of separation of the ions and transport numbers in the case of bipolar conductors and mixed crystals, and the parallelism between conductivity and diffusion phenomena and its application to conductors which are not purely electrolytic, are considered. H. F. G.

4634. Electrical Conductivity of Solids in Strong Fields. A. v. Hippel. *Zeits. f. Elektrochem.* 39. *pp.* 506–512, *July*, 1933.—An account is given of the electrical and thermal types of rupture of poor conductors in strong fields, the relation of the path taken by the discharge to the crystal structure and the direction of the field, and the probability of excitation of lattice vibration as a function of the electron velocity.

Measurements of the breakdown potentials of the alkali halides (up to $3 \cdot 1 \times 10^6$ volts per cm.) in an apparatus designed to eliminate edge effects are described; the electrical strength falls regularly as the sizes of the kations and anions are increased, and simultaneously the relation of the path of the discharge through the crystal to the crystal structure varies. The results afford quantitative support to the view that ionisation by impact is probable when the external field is sufficiently strong to transfer the electrons, between two impacts, across the zone in which retardation is a maximum. H. F. G.

4635. Conductivity of Electrolytic Solutions in Strong Fields and at High Frequencies. P. Debye. *Zeits. f. Elektrochem.* 39. *pp.* 478–482; *Disc.*, 482, *July*, 1933.—Principally a review of the development of modern theory, dealing largely with the results of the existence around each ion of an envelope of ions of opposite sign, the interpretation of the Wien effect in terms of the breakdown of such envelopes in strong fields, and the increase of conductivity under the influence of currents of frequency comparable with the time required for the renewal of the ionic envelope as the ion moves to and fro across the field. H. F. G.

4636. Conductivity in Solvents Having Very Small Dielectric Constants. R. M. Fuoss. *Zeits. f. Elektrochem.* 39. *pp.* 513–516, *July*, 1933.—The properties of electrolytic solutions may in general be derived from Coulomb's law. In solvents of high dielectric constant the ions are to a certain extent free, *i.e.*, they exert an average effect on one another as indicated by the Debye-Hückel equations, but with decreasing dielectric constant the interionic forces increase with the result that two or more ions group together to form ion pairs, triplets, quadruplets, etc., according to the relation between the potential energy of the complex and the mean energy of the thermal movements of the ions. H. F. G.

4637. A.C. Conductivity and Dielectric Constant of Electrolytes. P. Wenk. *Ann. d. Physik*, 17. 6. *pp.* 679–698, *July*, 1933.—Extends Wien's method of simultaneous measurement of a.c. conductivity and dielectric constant of aqueous solutions to a.c. of 1 m. wave-length in order to investigate Debye and Falkenhagen's dispersion theory in that region. Qualitative agreement between experiment and theory is claimed.

J. E. R. C.

4638. Effect of Viscosity upon the Conductivity and Dielectric Constant of Electrolytes. O. Dobenecker. *Ann. d. Physik*, 17. 6. *pp.* 699–715, *July*, 1933.—The a.c. conductivity and dielectric constant of electrolytes is measured by Wien's method [see preceding Abstract]. The viscosity of the solution is varied by adding cane sugar which, however, introduces anomalous dipole absorption and dispersion of the dielectric constant in the short-wave region (4–14 metres). These anomalous effects are dealt with. The time effect of the conductivity shows in accordance with the theory of Debye and Falkenhagen an increase with the sugar concentration valency of the ion and the a.c. frequency. The dielectric constant also shows a time effect which agrees qualitatively with theory.

J. E. R. C.

4639. Conductivities and Dielectric Constants of Liquids in H.F. Fields. M. Wien. *Phys. Zeits.* 34. *pp.* 625-627, *Aug.* 15, 1933.—The behaviour of a liquid towards alternating currents is dependent on its conductivity and dielectric constant, but the quantitative relationships

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are complicated by a series of effects which are discussed in the present paper in the following order: electric pressure, voltage-dissociation, time, dipole. Experimental data are afforded from solutions in acetone, aqueous solutions of weak acids, salts and bases (ammonia, methylamine), and sugar solutions. H. H. Ho.

4640. Electrical Conductivity of Monovalent Salts in Ethyl Alcohol. M. Barak and H. Hartley. *Zeits. f. phys. Chem.* 165. *Abt.A.* 4–5. *pp.* 272–293, *July*, 1933.—The conductivities of 25 single monovalent salts dissolved in ethyl alcohol were measured at 25° C. at concentrations from $0 \cdot 0001\ N$ to $0 \cdot 0013\ N$. In most cases the results showed considerable deviations from the calculated values obtained from the Debye-Hückel-Onsager equation. F. J. B.

4641. Conductivity Relationships of Non-Aqueous Solutions. H. Ulich. *Zeits. f. Elektrochem.* 39. *pp.* 483–489; *Disc.*, 489. *July*, 1933.—Whilst the conductivity relationships of different types of electrolytes in various solvents are governed primarily by the physical properties of the latter, the type to which a given substance belongs depends largely on the chemical nature of the solvent. Solutes may be classified as true electrolytes, in which the ions may be regarded as pre-existent, and potential electrolytes, which yield ions only on exchange of material with the solvent. The true electrolytes may be strong or weak, according to the solvation affinity of the ions. Three groups of potential electrolytes are recognised, *viz.*, those in which (*a*) electron transfer occurs, (*b*) exchange of protons is necessary for electrolyte formation, and (*c*) exchange of a halogen ion occurs. Group (*a*) includes probably many of the abnormal solutions in liquid sulphur dioxide, and solutions of metals and nitrocompounds in ammonia; group (*b*) is the best known type; whilst an example of the group (*c*) type is probably afforded by the solution of aluminium chloride in carbonyl chloride. H. F. G.

4642. Conductivity and Nature of Electrolytes in Metal Alkyls. F. Hein and H. Pauling. *Zeits. f. phys. Chem.* 165. *Abt.A.* 4–5. *pp.* 338–366, *July*, 1933.—The conductivities of solutions of various tetra-alkylammonium halides in zinc methyl and zinc, cadmium, and aluminium ethyls have been determined at a number of concentrations. Of all the salts studied, only tetrabutyl- and tetraamyl-ammonium iodides are miscible with the solvents, and the solutions yield a conductivity-concentration curve with a pronounced maximum at high concentrations; if the conductivity is corrected for viscosity, however, the curve becomes of the type $\mu v^n =$ constant, where v is the dilution. For a given kation (or anion) the conductivity increases with the weight of the anion (or kation). The solvents behave as typical slightly ionising media, in accordance with their low dielectric constants. As a consequence of the different solvation effects, the powers of dissolution and ionisation of the solvents decrease in the order given above. The osmotic pressures of the solutions are high owing to marked solvation. H. F. G.

4643. Conduction in Dielectric Liquids at High Pressures. H. Edler and G. Zeier. *Zeits. f. Physik*, 84. 5–6. *pp.* 356–363, *July* 31, 1933.—Current conduction was investigated in relation with the pressure in high fields (in the region of collision ionisation), in the case of a very pure transformer oil. The current decreases according to an exponential law with increasing pressure. The course of the curve showing the relation between current and field strength is independent of the pressure. Accordingly not the production of new electricity carriers, but the transition of the electrons from the metal into the liquid is influenced. Accordingly as the dependence of the pressure exponent on the temperature this can be explained as a change of the number of the electrons standing free for disposal on transition from the metal to the liquid (reflection of the electrons at the metal surface) or as increase in magnitude of the emergence work. J. J. S.

See also Abstracts 4316, 4657, 4669.

DIELECTRICS AND CAPACITANCE.

4644. Unipolarity of the Polarisation in Rochelle-Salt Crystals. I. Kurtschatow. *Phys. Zeits. d. Sowjetunion,* 4. 1. *pp.* 125–129, 1933. *In German.*—Most authors who have investigated this phenomenon are inclined to ascribe it to the lattice properties of the crystal [see Staub, Abstract 3178 (1933) and Oplatka, Abstract 3179 (1933)]. The results now recorded indicate, however, that the unipolarity is connected with the imperfection of the crystal and the presence therein of mechanical stresses. Owing to the marked polarisation capacity of the crystal under the influence of mechanical forces, a polarisation of the crystal in a definite direction is produced, so that the values of both the dielectric constants and the saturation for different directions of the field are different. T. H. P.

4645. Anomalous Dispersion of the Dielectric Constant of Rochelle Salt. G. Busch. *Helv. Phys. Acta,* 6. 5. *pp.* 315–336, 1933. *In German.*—It is shown that the anomalous dispersion of the dielectric constant of Rochelle salt found by Errera [see Abstract 3941 (1931)] is not a molecular characteristic of the substance, but that it depends on piezoelectric vibration of the whole crystal. The influence of the temperature on the frequency of the characteristic vibration of a Rochelle salt crystal was also investigated. J. J. S.

4646. Specific Inductive Power and Water of Crystallisation of Alums. J. Errera and H. Brasseur. *Comptes Rendus,* 197. *pp.* 480–482, *Aug.* 16, 1933.—It has been shown previously [see Abstract 3177 (1933)] from a study of different crystals containing water of crystallisation, that the specific inductive power varies according to the direction and this dispersion is attributed to the water of crystallisation. The work has now been extended to two families of alums which form isomorphous crystals containing 12 molecules of water, *viz.,* Cs, Rb, NH_4, K, Tl, Al $(SO_4)_2$, $12H_2O$ and Al, Cr, Fe, $WH_4(SO_4)_2$, $12H_2O$. Here the specific inductive power is small, notwithstanding the large number of molecules of water. These alums do not exhibit a dispersion between 8 m. and 400 m., except ferric alum which is moreover the most unstable. The specific inductive power is greatest when the atomic volume is least, and when the vapour tension is greatest. The measurement of specific inductive power is found to be a measure of the force with which water of crystallisation is retained by the solid. The parallelism between the atomic volume of the metal and the dielectric constant of the crystal suggests the possibility that the metallic atoms are in the condition of neutral atoms rather than of ions. H. H. Ho.

4647. Free Rotation and the Electric Moments of Diacetyl, Acetylacetone, Acetic Anhydride, and Acetoacetic Ester. C. T. Zahn. *Phys. Zeits.* 34. *pp.* 570–574, *July* 15, 1933.—The calculated electric moment of diacetyl is much larger than the observed, indicating an impedance of the free rotation; the electric moment shows also a temperature effect. Acetylacetone shows no temperature effect in the temperature interval, 50–200° C. The isomeric modifications of this compound are discussed and it is concluded that in the liquid state it consists most probably of an equilibrium mixture of 20 % of the keto and 80 % of the enol modification. Electric moments, with and without free rotation, are calculated for the diketone, the enol-ketone, and the dienol modifications. The same operations have been performed for acetic anhydride and for aceto-acetic ester, neither of which exhibit a temperature effect. The relation between the electric moment and the inner association of the molecule is also discussed. W. R. A.

4648. Dipole Moment and Association. G. Berger. *Zeits. f. phys. Chem.* 22, *Abt.B.* 4. *pp.* 283–297, *Aug.*, 1933.—The association of a large number of aromatic compounds has been determined ebullioscopically in benzene solution and compared with their dipole moments. An approximate proportionality between association and dipole moment is only found for the monosubstituted and for the positional isomeric disubstitution derivatives of benzene. Deviations from proportionality are explained on the assumption that in addition to the total moment, the group moments of the substituents are also responsible for the association. The abnormally strong association of alcohols, phenols, and acids is ascribed to the increase of the hydroxyl moment with concentration. The importance of the latent dipole of the benzene nucleus for association is discovered. H. H. Ho.

4649. Electrostriction Produced by Salts in some Aliphatic Alcohols. W. C. Vosburgh, (Miss) L. C. Connell and J. A. V. Butler. *Chem. Soc., J. pp.* 933–942, *Aug.*, 1933.—The apparent molar volumes of LiCl, NaCl and KCl, and NaI and KI in MeOH, and of LiCl in four of the lower aliphatic alcohols have been determined. [See Abstract 3659 (1931).] All the salts obey the equation $\phi = \phi_0 + a\sqrt{c}$ over the concentration range examined, except when saturation with some of the higher alcohols is approached. The differences of a for the various salts in MeOH are greater than the experimental error, but the average value of a, which is six times the value in water, is in approximate agreement with the limiting value for uni-univalent salts in this solvent calculated from Redlich and Rosenfeld's equation. [See Abstract 3665 (1931).] The electrostriction by the ions is considerably greater in the alcoholic than in aqueous solutions. The extrapolated values of the apparent molar volumes at infinite dilution in water and MeOH are in reasonable agreement with values calculated by Webb's theory of electrostriction. [See Abstract 812 (1927).] In propyl and *n*- and *iso*-butyl alcohols a small variation of the mean ionic radius of LiCl suffices to make the calculated values of ϕ_0 agree with those observed. T. H. P.

4650. Temperature and Pressure Dependence of the Dielectric Constants of the Vapours of Bromine and of Iodine Chloride. K. F. Luft. *Zeits. f. Physik*, 84. 11–12. *pp.* 767–782, *Aug.* 21, 1933.—Measurements have been carried out by means of a suspension method, and the dipole moment of bromine found to be zero to within an error

of $0\cdot1 \times 10^{-18}$. The data of other authors are discussed and the attempt made to explain contradictory results. For iodine chloride, the dipole moment is determined by extrapolation to be $\mu = 0\cdot5 \times 10^{-18}$ units.
H. H. Ho.

4651. Dielectric Constants of Organic Liquids. S. Sugden. *Chem. Soc. J. pp.* 768–776, *July,* 1933.—The determination of the dielectric constants of organic liquids by a resonance method at radio frequencies is described in detail. The cells were of the Sayce and Briscoe type and the method of silvering is discussed. An end effect in the cell is discussed and the extent of the error introduced by it is considered; likewise a smaller error arising from the position of the make and break. Corrections depending on the resistance of the cell, the inductance of the leads and the frequency of the alternating current are considered also and applied to the results. The values for six organic liquids at 25°C. and at 200 kc./sec. or less are as follows :—benzene, 2·272 ; chlorobenzene, 5·612 ; ethylene dichloride, 10·36 ; acetophenone, 17·39 ; benzonitrile, 25·19 and nitrobenzene, 34·75. The value for benzene is in good agreement with Hartshorn's value and the value for benzonitrile agrees well with Ball's value. Ball's value for nitrobenzene is 0·26% higher than the value found by Sugden. The dielectric constants are in each case independent of the frequency up to 10^3 kc./sec. W. R. A.

4652. Dielectric Constants of Dilute Strong Electrolytes. M. Jezewski and J. Kamecki. *Phys. Zeits.* 34. *pp.* 561–565, *July* 15, 1933.—Using four different types of condensers, which are described, the dielectric constants of solutions of various concentrations of hydrochloric acid, sodium chloride, potassium chloride, magnesium sulphate and copper sulphate have been determined. Observed data are compared with calculated values and fairly satisfactory agreement is obtained.
W. R. A.

See also Abstracts 4637, 4638, 4639.

ELECTROCHEMISTRY.

4653. Magnitudes of Electrolytically-Produced Gas Bubbles. B. Kabanow and A. Frumkin. *Zeits. f. phys. Chem.* 165. *Abt.A.* 6. *pp.* 433–452, *Aug., and* 166. *Abt.A.* 3–4. *pp.* 316–317, *Sept.,* 1933.—The interpretation by Coehn and his co-workers [see Abstracts 2340 and 2341 (1923) and 713 (1924)] of the changes in size of electrolytically produced gas bubbles as due to the action of electrophoretic forces is unsatisfactory for the usual conditions of electrolysis, since this effect is infinitesimal. Another explanation is now proposed according to which the size of a bubble parting from the electrode is determined by the marginal angle at the boundary electrode-solution-bubble. This explanation is in agreement with Coehn's empirically found dependence of bubble size on the composition and concentration of the solution, as also on the direction and strength of the current. Curves are drawn for bubbles at electrodes of mercury, silver and platinum for solutions of Na_2SO_4, NaOH and H_2SO_4 at concentrations of 1 to 0·001 normal. Further, bubble-size is shown to be dependent on the potential of the electrode which is affected by its polarisation. The course of the parabolic curve for diameter-potential at the mercury electrode is found to run parallel with the electro-capillarity curve for mercury. A calculation is given of the forces acting upon the bubble which show that up to the moment of rupture, the equilibrium state of the bubble is completely determined by the surface forces, the hydrostatic pressure and the internal

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gas pressure within the bubble. The practical importance of the theory is discussed with examples from the electrolysis of zinc. H. H. Ho.

4654. Kathodic Generation of Hydrogen. J. Hoekstra. *Zeits. f. phys. Chem.* 166. *Abt.A.* 1–2. *pp.* 76–80, *Sept.*, 1933.—It is shown that the Volmer assumption [see Abstract 1059 (1931)] of an arrested ionic discharge must lead to the occurrence of a species of limiting current. H. H. Ho.

4655. Activity Coefficient of Potassium Chloride in Aqueous Solutions at 0°C. R. P. Smith. *Am. Chem. Soc., J.* 55. *pp.* 3279–3282, *Aug.*, 1933.—The activity coefficient of KCl was determined from measurements of e.m.f. of the cell Ag/AgCl/KCl (1 *M.*)/K Hg/KCl (0·1 *M.*)/AgCl/Ag at 0°C., and from measurements of the freezing point. The activity coefficient was calculated for solutions of KCl at concentrations ranging from 0·1 *M.* to 3·5 *M.*, at 0°C. An extended Debye-Hückel equation was given, by means of which the activity coefficient of KCl could be reproduced at 0°C. over the entire range of concentration. F. J. B.

4656. Internal Mobility of Solids. G. v. Hevesy. *Zeits. f. Elektrochem.* 39. *pp.* 490–500, *July*, 1933.—The possibility of internal transport in solids is an inherent property of substances of high energy content. The accumulation of energy at various points of the crystal reduces the forces between the components and thereby increases the mobility of the latter, but the result depends to a very varying extent on the size, charge, and degree of polarisation of the components. Similar effects may be produced by mechanical disturbance of the crystal. Various typical cases are discussed in some detail. H. F. G.

4657. Transport of Material and Passage of Current in Liquid Alloys. K. Schwarz. *Zeits. f. Elektrochem.* 39. *pp.* 550–554; *Disc.*, 554, *July*, 1933.—The movement of material during the passage of current in amalgams of various metals was studied. The transport numbers were measured directly and also calculated from diffusion potentials. The results indicated the existence of metal ions in the molten alloys, the ions corresponding to the lowest valency. In the electrolysis of liquid binary alloys, the ion with the greater density of charge migrated to the kathode. F. J. B.

4658. Constitution of Anodically Formed Ta_2O_5 Layers. P. O. Schupp. *Zeits. f. Physik*, 84. 7–8. *pp.* 412–424, *Aug.* 7, 1933.—Current-voltage curves for formed tantalum anodes are determined in various aqueous and non-aqueous solutions. [See Abstract 365 (1933).] The ageing phenomena are the same in both cases. Detailed investigation of the forming of tantalum in non-aqueous solvents, including capacity measurements, allows of a decision between the alternative " resistance " and " liberation " theories put forward by Güntherschulze and Betz [see Abstract 3060 (1932)], and indicate that the " resistance " theory is untenable. It is found possible to arrest the growth of the protective layer at an intermediate stage in which it is " porous " in character, whereas the completed layer is non-porous. The results indicate that the size of the pores is inconsistent with the Müller theory of electrolytic valve action. L. A. W.

4659. Junction Potentials between Glass and Salts in Fusion. H. B. Elkins and G. S. Forbes. *Am. Chem. Soc., J.* 55. *pp.* 3250–3260, *Aug.*, 1933.—The e.m.f.'s of cells of the type Ag_1/AgCl + LiCl (+ KCl . . .)/glass/KNO_3 + $NaNO_3$/glass/AgCl + LiCl (+ KCl . . .)/Ag_2

were measured at 500°. Some cells involving silver bromide were also measured. Single alkali chlorides and low melting mixtures of lithium and potassium chlorides were used as "solvents." An alkali salt was found necessary to stabilise the e.m.f. An equation derived on the assumption of a concentration cell with transference by kation alone seemed to describe the e.m.f's satisfactorily. "Transference constants," dependent on the readiness with which metallic ions entered the glass, were calculated and it was found that $K_{Li} > K_{Na} \gg K_{K} > K_{Rb} \gg K_{Cs} > K_{Ag}$, the order of the alkali ions being ascribed to higher mobility of the smaller ion, and the small value of K_{Ag} to the great stability of the silver chloride. Integration of the Gibbs-Duhem-Margules expression made possible the calculation of deviation from laws of perfect solution. N. M. B.

See also Abstracts 4316, 4633, 4635, 4636.

ELECTRONS AND PROTONS.

4660. Diffusion of Electrons and Distribution of Momenta. J. Winter. *J. de Physique et le Radium*, 4. *pp.* 316–323, *June*, 1933.—To deal with the Ramsauer-Townsend effect and related problems the author used an idea suggested by Sommerfeld, which consists in determining the perturbation caused by a scattering body in the propagation of a plane wave by assuming the form of the expression of the perturbed wave at infinity. If the perturbating potential, which represents the influence of the scattering atom, is spherically symmetrical it may be assumed that at infinity the perturbed wave will comprise (1) the original wave and (2) a spherically divergent wave introduced by the perturbing body. With the help of wave-mechanics it is shown that this method is fruitful and gives a satisfactory mathematical solution of the problem. The hypotheses adopted by Allis and Morse in dealing with the Ramsauer-Townsend effect are discussed and criticised. H. L. B.

4661. Conditions for the Occurrence of the Ramsauer Effect. W. Voss. *Zeits. f. Physik*, 83. 9–10. *pp.* 581–618, *July* 6, 1933.—According to classical mechanics an electron of low velocity may move in the field of an atom both far outside and also inside the atom so long as its moment of momentum is sufficiently small. The inner and the outer orbit are separated from one another by a potential barrier. At higher velocities the barrier vanishes, so that an electron that comes from outside may penetrate deeply into the interior of the atom. The possibility of the existence of inner and outer orbits is shown to be the decisive feature for the Ramsauer-Townsend effect. At low velocities (that is, small energy) an electron that comes from outside cannot penetrate into the interior of atoms even according to wave-mechanics, and hence is but little influenced by the atom and but little scattered. At higher velocities (greater energy) it penetrates the potential barrier and hence experiences a sudden and sharp deflection. This view is illustrated by an example and is proved generally. The calculations link up with a method due to Wentzel, Kramers and Brillouin. It is also shown why the alkali metals and in general large atoms exhibit no Ramsauer-Townsend effect. A method of deriving the scattering parameter from observations of the angular distribution of slow scattered electrons is also described and is illustrated in the case of krypton. H. L. B.

4662. Effect of Neutral Gas Molecules on Slow Protons. (Total Effect, Scattering, Transfer of Charge.) C. Ramsauer and R. Kollath. *Ann. d. Physik*, 17. 7. *pp.* 755–780, *Aug.*, 1933.—Two previous papers of the authors on cross-sections and scattering in relation to slow protons are here supplemented by experimental results for neutral gas molecules. The cross-section measurements with respect to protons are extended to the gases krypton, xenon and methane, the scattering measurements are extended to krypton and xenon. Investigation of the charge and velocity of the slow particles that occur in the scattering measurements makes it appear probable that the particles are neither secondary electrons nor retarded protons but positively charged gas molecules that have been formed by attachment or ionisation processes. The number of these attachments is measured relatively to the number of those collisions that lead to elastic scattering of the protons for various gases and various velocities of the protons. A noteworthy feature is that, just as in the case of cross-sections with respect to slow electrons, methane fits in with the inert gases in its behaviour, but here it resembles xenon rather than krypton. It appears that the attachment cross-sections do not go to zero when extrapolated but to a constant value. An unambiguous relationship between attachment cross-section and ionising potential seems to exist only for the inert gases. The velocity and the direction distribution of the molecules which suffer impacts are deduced from the behaviour of the elastically scattered protons. H. L. B.

4663. Principles Underlying Cross-Section Measurements of Gas Molecules. H. L. Brose. *Ann. d. Physik,* 17. 7. *pp.* 816–820, *Aug.,* 1933.—Referring to a paper by Kollath [see Abstract 1194 (1933)] the author points out that the results obtained by the two different methods of Ramsauer and Townsend for the cross-sections of gas-molecules with respect to slow electrons are bound to differ, as they involve different assumptions. Some artificial hypothesis concerning the diameter or cross-section of a molecule is necessarily postulated. Collisions involving marked electrical repulsions such as occur between electrons are different from those between molecules. In Townsend's experiments the collisions between electrons and molecules are compared with those between perfectly smooth elastic and spherically symmetrical spheres. It would be manifestly absurd to say that in the Ramsauer-Townsend effect the molecules assume different diameters for different speeds of the colliding electrons. All that is implied is that the nature of the collisions between electrons and molecules does not resemble to the same extent the collisions between elastic spheres for different molecular velocities. H. L. B.

4664. Effect of Exchange on the Scattering of Slow Electrons from Atoms. P. M. Morse and W. P. Allis. *Phys. Rev.* 44. *pp.* 269–276, *Aug.* 15, 1933.—Reasons are given why the Born approximation is incapable of dealing with the scattering of slow electrons. Since this approximation assumes that the sine of the phase angle δ equals δ, the results computed by the Born method become completely unreliable when δ is greater than $\pi/2$. Exact solutions then must be obtained. Equations are set up, including exchange effects, for the best possible wave function for an electron scattered from hydrogen or helium when the complete wave function is of the separable type usually used in atomic theory. These equations are solved on the differential analyser to find the best possible curves for the δ's, for the angle distribution of scattering and for the total cross section, for this type of wave function. The check with experiment for helium is good, the maximum discrepancy in any of the δ's being only ten degrees. No data for atomic hydrogen are available. The small error introduced by the use of separable wave functions (neglect of polarisation) is discussed. The conclusions are that exchange effects are not important for electron energies greater than 30 volts, and below this energy have an appreciable effect only on the angle distribution curves, and not on the cross section curves. An analytic solution of the equations, valid for any atom having closed electronic shells, is obtained for a simplified form of atomic wave functions and potential. The results confirm the above conclusions, and also show that exchange is less important in scattering from heavy atoms than from light ones. [See also Abstract 4806 (1932.] AUTHORS.

See also Abstracts 4308, 4375, 4481, 4556.

ELECTROSTATICS.

4665. Contact Potential Differences between Different Faces of Copper Single Crystals. H. E. Farnsworth and B. A. Rose. *Nat. Acad. Sci., Proc.* 19. *pp.* 777–780, *Aug.*, 1933.—A determination was made by the Kelvin null method of the contact potential difference between two different carefully prepared faces—(100) and (111)—of copper single crystals under various stages of outgassing in a high vacuum. The (111) face was found to be positive with respect to the (100) face, but only after outgassing the crystal at temperatures higher than that previously used to bake the whole tube. The results are in every case consistent with the view that the p.d. is increased by outgassing, and is decreased by evaporation which to some extent causes etching parallel to planes making angles other than zero with the surface. In these conditions a maximum p.d. of $0 \cdot 463 \pm 0 \cdot 002$ volt was found which was much larger than was anticipated. It is considered that most probably an intrinsic p.d. exists between the uncontaminated crystal faces which is equal to or greater than the highest observed value. It would appear that a check between the difference in photoelectric work functions and the contact p.d. is not necessarily to be expected for two polycrystalline surfaces. J. J. S.

See also Abstracts 4380, 4610.

GALVANOMAGNETIC AND THERMOMAGNETIC EFFECTS.

4666. Hall Effect and other Physical Constants of Alloys. Part I. Lead-Bismuth Series of Alloys. W. R. Thomas and E. J. Evans. *Phil. Mag.* 16. *pp.* 329–353, *Aug.*, 1933. *Supplement.*—A series of plates varying in composition from pure lead to pure bismuth was tested for resistivity, temperature coefficient of resistance, thermoelectric power with respect to copper, density and Hall effect. The most interesting variations in these physical properties occur in the region of low lead content. Curves showing the relation between Hall coefficient and composition, for magnetic fields of about 3100, 6800 and 8900 gauss are similar in shape, and the curve corresponding to the strongest field crosses the line of zero Hall coefficient three times. G. E. A.

4667. Theory of the Anomalous Magnetic and Thermoelectric Effects in Metals. D. Blochinzev and L. Nordheim. *Zeits. f. Physik,* 84. 3–4. *pp.* 168–194, *July* 26, 1933.—The theory of the thermoelectric and the galvanomagnetic effect in metals can be developed under more general hypotheses as to the characteristic value distribution (*i.e.*, the energy as function of the wave numbers) than has hitherto been done. It is not necessary to assume that the energy possesses the same formal dependence on the wave number as in free electrons but it is sufficient that the whole characteristic value spectrum is split up into partial zones and in the neighbourhood of the null point energy the energy is a quadratic function of the wave number which varies from zone to zone and does not require to be spherically symmetrical. For divalent metals this hypothesis might be approximately fulfilled. By it is developed the theory of the Thomson effect, Hall effect, and the change of resistance in the magnetic field, as well as an estimation of the characteristic value distribution according to the disturbance process of Peierls. A more general view point is thus obtained which gives at least a qualitative survey of the behaviour of anomalous effects. A numerical comparison in special cases shows that the effects in question can be explained as far as order of magnitude is concerned. J. J. S.

4668. Electrical Resistance of Ferromagnetic Metals in relation to the Magnetic Properties. A. Drigo. *N. Cimento,* 10. *pp.* 172–187, *April,* 1933.—The relation between electrical resistance and applied magnetic field which has been studied with change of temperature in the case of nickel [see Abstract 5162 (1932)] is here extended to other multicrystalline magnetic materials and other conditions. The substances are subjected to extension and torsion alone and their resistance found with varying temperature, then the effect under the same conditions but with the addition of a magnetic field is studied. The results are used to elucidate the mechanism of the magnetic effects. H. M. B.

4669. Physical Significance of Apparent Irregularities in the Magneto-Resistance Curves of Nickel. M. M. S. Gupta and M.S. Alam. *Indian Journ. Phys.* 8. *pp.* 9–17, *July* 15, 1933.—The change of resistance of nickel in small longitudinal magnetic fields is studied with a view to determine the reality of negative changes and intersections of individual parts of the resistance-hysteresis curves. It is found that the negative change is a physical reality and not an experimental error. It is a record of the previous magnetic treatment of the material, and depends on the maximum field used in a cycle. The negative change is not observed even with a sample possessing residual magnetism at the beginning, if the maximum field to which it is subjected during a resistance-hysteresis cycle is above a certain value. It is suggested that the real " zero state " of a sample is the state corresponding to its minimum resistance in a cycle. The intersections of parts of the resistance-hysteresis curves are found to be real. As these intersections do not occur in the curves of magnetism, they seem to be associated with process of electrical conduction in metals. A new field of investigations is thus opened for theoretical physicists. The existing theories of electrical conduction are unsatisfactory. The formulation of a theory, relevant with observed facts, is necessary. AUTHORS.

See also Abstract 4708.

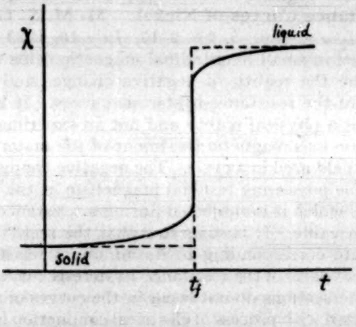
MAGNETISM AND ELECTROMAGNETISM.

4670. Non-Existence of a Permeability Anomaly in Iron between Wave-Lengths 84–1300 m. G. R. Wait. *Zeits. f. Physik,* 83. 11–12, *pp.* 786–788, *July* 8, 1933.—Criticism of work by Malov and Arkadiew [see Abstract 2403 (1927)]. W. R. A.

4671. Remanence of Single Iron Crystals. S. Kaya. *Zeits. f. Physik,* 84. 11–12. *pp.* 705–716, *Aug.* 21, 1933.—It is shown experimentally that the remanence of crystals of iron is given by the expression $I_8 /(l + m + n)$, where I_∞ represents the saturation value of the magnetisation and l, m, n are the direction cosines of the external field as related to cubical or three dimensional spacial axes of coordinates. The divergences and errors of earlier theories on this subject are discussed, *i.e.*, the theory of the magnetisation curve, and the relationship to the present statement are set out and explained. S. G. B.

4672. Diamagnetic Susceptibility of the Hydrogen Molecule. K. Honda and T. Hirone. *Zeits. f. Physik*, 84. 3–4. *pp.* 208–211, *July* 26, 1933.—The lack of agreement between observed and calculated values for the molecular diamagnetic susceptibility of hydrogen arises from a thermal rotation in the molecule. This thermal rotation produces a paramagnetic susceptibility which is independent of temperature and equal to $0 \cdot 35 \times 10^{-6}$. When this is added to the value calculated by van Vleck the calculated diamagnetic susceptibility of hydrogen becomes $- 3 \cdot 85 \times 10^{-6}$ in good agreement with experimentally observed values. W. R. A.

4673. Diamagnetism and Temperature. B. Cabrera and H. Fahlenbrach. *Comptes Rendus*, 197. *pp.* 379–381, *July* 31, 1933.—A study of water, certain alcohols and other substances leads the authors to conclude that the general law of variation of diamagnetic susceptibility with temperature can be represented by a curve of the form given, in which χ is the susceptibility and t_f the temperature of fusion. For temperatures at some distance from the melting point χ may be regarded as constant, being greater for the liquid than for the solid; the difference is ascribed to the action of forces in the crystal. The effect of the constitution on the variation of χ near the melting point, and other aspects of the problem, are discussed. G. E. A.



4674. Paramagnetism and Chemical Union. E. Rabinowitsch. *Zeits. f. Elektrochem.* 39. *pp.* 702–715, *Aug.*, 1933.—Where applicable, the study of paramagnetism is shown to afford a very important contribution for the determination of the state of bound atoms and ions, and for the investigation of the different modes of chemical union. The present comprehensive paper deals with the following aspects of the subject: (*a*) Spin and orbit magnetism. (*b*) Magnetism of free atoms and ions with special reference to singlet and multiplet states, and with examples

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from the rare earths. (*c*) Extinction of orbit magnetism by electrical forces; in this section the theory is derived, with examples of ions of the iron series, complexes, and solutions with entire spin-magnetism. (*d*) Change of spin-magnetism by chemical valency forces, with examples of diatomic molecules, of complexes with complete or partial extinction of spin-magnetism, and of semi-metallic compounds. H. H. Ho.

4675. Paramagnetism and the Molecular Field of Neodymium. P. W. Selwood. *Am. Chem. Soc., J.* 55. *pp.* 3161–3177, *Aug.*, 1933.—Measurements of magnetic susceptibility over the range − 190° to 100° C. were made for Nd_2O_3, NdF_3, $Nd(NO_3)_3$, $Nd(ClO_4)_3$, $Nd_2(SO_4)_3$, $Nd_2(SO_4)\cdot 8H_2O$, La_2O_3 and certain mixtures of lanthanum and neodymium oxides. Data are also given for a solution of neodymium nitrate in ethyl alcohol, oxalic acid and pyrex glass. The results are discussed with reference to van Vleck's quantum mechanical theory of paramagnetism, and especially with reference to the Weiss molecular field and its dependence on crystalline field and exchange interaction. In general the theory is supported although discrepancies occur. [See also Abstract 3224 (1931)]. G. E. A.

4676. Magnetic Properties of Substances with Artificial Anisotropy. W. König. *Ann. d. Physik*, 17. 7. *pp.* 736–746, *Aug.*, 1933.—A method is described by which short cylinders of gelatin are produced in a state of strain. The gelatin when hung with axis vertical in a horizontal magnetic field is subjected to a turning moment, which depends on the difference of the susceptibilities along and perpendicular to the axes of anisotropy, and on the angle which these axes make with the lines of force. The susceptibility of the undeformed substance was also measured. The amount of anisotropy present is illustrated by results obtained by Brauneck and Weisel for gelatin alone and gelatin with addition of various salts [see following Abstract]. G. E. A.

4677. Magnetic Tests of Artificial Anisotropy in Celloidin, Agar-Agar and Celluloid. K. Weisel. *Ann. d. Physik*, 17. 7. *pp.* 747–754, *Aug.*, 1933.—The experiments with the first two substances were unsuccessful, and the anisotropy is measured for celluloid. The results confirm the assumption that the difference of the deformations in the directions of the principal stresses is proportional to the difference of the susceptibilities. The direction of strongest magnetisation does not, however, always coincide with the axis of tension. [See also preceding Abstract.] G. E. A.

4678. Electromagnetic Fields due to Variable Electric Charges and the Intensities of Spectrum Lines according to the Quantum Theory. V. Fock. *Roy. Soc., Proc.* 141. *pp.* 550–553, *Sept.* 1, 1933.—The paper is a criticism of a paper by Schott [see Abstract 1645 (1933)]. It is shown that Schott's conclusions cannot be substantiated, and that the usual methods of calculating the intensities of spectral lines are correct. AUTHOR.

4679. Magnetic After-Effect. P. C. Hermann. *Zeits. f. Physik*, 84. 9–10. *pp.* 565–570, *Aug.* 12, 1933.—In the generally accepted explanation of magnetic after-effects it is hypothesised that eddy currents play a considerable rôle in the production of the phenomenon. The present work shows that after-effects of considerable duration are observed which must lie outside the limits of eddy current effects. Particular observations are made upon the occurrence of the phenomenon in the case of small induction and low frequencies. With unalloyed soft iron at small fields of the order one to four m. oersted, and low frequencies of 0·12 to 2 hertz, a strong after-effect is produced. The effect would signify that a hypothetical value for direct current initial permeability of 2800 gauss oersted to 2000 gauss oersted exists (ballistic), but at 30 hertz the value drops to 1100 gauss oersted. The angle of loss due to the after-effect for the smallest measured frequencies and the least field strength is of the order $\Delta R/\omega L = 0\cdot 3$. The limitation of the effect by eddy currents and hysteresis influence is determined and discussed in several ways whilst finally the Jordan after-effect coefficient is calculated. S. G. B.

4680. Extension of a Maxwell Mutual-Inductance Formula to Apply to Thick Solenoids. H. B. Dwight and S. H. Chen. *Physics*, 4. *pp.* 323–326, *Sept.*, 1933.—The formula for the mutual inductance of two concentric solenoids which is used probably more than any other is the one originally given by Maxwell. Since the solenoids were taken to have negligible thickness in the above formula and since the effect of the thickness is often appreciable in practical cases, additional terms to give the effect of the thickness have been calculated. AUTHORS.

4681. Magnetisation and Magneto-Resistance. N. G. Alocco. *N. Cimento*, 10. *pp.* 153–168, *April*, 1933.—Results of some magnetometric measurements which, combined with the study of the variations of electric resistance under magnetisation enable the particular magnetic properties to be analysed for various polycrystalline metals, tracing these through the modifications which these undergo under given elastic deformations. A. D.

4682. Gyromagnetic Experiments on the Process of Magnetisation in Weak Fields. S. J. Barnett. *Am. Acad., Proc.* 68. *pp.* 229–249, *June*, 1933.—If a rod of iron is rotated about its axis it becomes longitudinally magnetised in the direction opposite to that in which it would be magnetised by an electric current flowing round in the direction of rotation. The magnetisation thus produced is not due to the rotation of the rod as a whole, but to the rotation of the magnetic elements which are entrained in the motion of the rod. The idea arose that if the rod when at rest were magnetised transversely, and the magnetisation rotated by a two-phase electrical system in a plane normal to its axis, longitudinal magnetisation would result. The work of Tonks, Fisher and the author on this point is described and forms the basis of the present work. The author describes in minute detail the theory and practical issues of his experiments and shows that in one set of results for permalloy he obtained a mean magnetometer reflection which was negative, whereas theoretically it should have been positive. Taking permalloy and iron dust he shows that the calculated values are always higher than the experimental results. It is shown that when the magnetisation vector itself rotates, as in the present experiments, the conditions are far more complex than when the rod itself rotates, and it is impossible to give any detailed theory of what happens if the elements themselves rotate. The author concludes that any rotation of the elements which could possibly occur, would be accompanied by changes of magnetisation much less than the minimum detectable in this work and that the most probable explanation of the null effect is due to Einstein, that the elements do not rotate with the field at all, but have their moments periodically reversed by the rotating field. If this is so, it can be shown that

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the magnetisation vector will rotate without any rotation of the elements and thus without the production of any longitudinal magnetisation by a gyromagnetic process. The present work strongly supports the evidence in favour of the hypothesis that in the early part of the magnetising process for weak fields, the magnetisation proceeds by such quantum jumps, or reversals of the elements, and not by changes of orientation. In strong fields however, the indications are that changes of magnetisation are due to gradual changes in the orientation of the elements. Experiments on these lines are now being conducted. S. G. B.

4683. Gyromagnetic Effects: History, Theory and Experiments. S. J. Barnett. *Physica*, 13e. 8. *pp.* 241–269, 1933. *In English.*—A critical survey of the subject of the title. The author discusses his own and other published work in the form of a brief review of the literature and of present knowledge. [See preceding Abstract.] S. G. B.

4684. Energy Loss Testing of Magnetic Materials Utilising a Single Strip Specimen. C. Dannatt. *Journ. Sci. Instruments*, 10. *pp.* 276–285, *Sept.*, 1933.—The article refers to the need for a method of measuring energy loss in single strip magnetic specimens under alternating magnetisation. The theory development and the performance of such a tester are then described. Special attention is directed in the Appendices to the question of harmonics in the flux and current waves, and the power associated with the harmonics. It is shown how in practice the tester can be so designed to eliminate difficulties due to harmonics up to fairly high densities. AUTHOR.

4685. Determination of the Magnetic Properties of Laminated Rings. H. Kühlewein. *Zeits. f. techn. Physik*, 14. 8. *pp.* 314–316, 1933.—The paper describes two practical methods for investigation of the magnetic properties of high permeability material in the form of laminated rings, which rids the experiment of the difficulties due to the disturbance by demagnetisation factors. The first method allows the magnetisation to be developed without time loss in one or more of the primary magnetic circuits which lie in a ring bundle, and the second allows the Curie point to be determined without time loss also. Full diagrams and experimental details are given. S. G. B.

4686. Magnetic Flux Recorder. O. v. Auwers. *Zeits. f. techn. Physik*, 14. 8. *pp.* 316–319, 1933.—Ewing first designed a method for the autographic recording of the hysteresis curve, and Kruger and Plendl adapted the Braun tube for the same purpose. The present method illustrates a photographic method of recording the flux changes in magnetisation by employing a special type of galvanometer (Kriechgalvanometer), as a fluxmeter. Examples of its use and constructional details are given. S. G. B.

See also Abstract 4629.

MEDICAL RADIOLOGY AND ELECTROLOGY.

4687. Physico-Mathematical Aspects of Nerve Conduction. N. Rashevsky. *Physics*, 4. *pp.* 341–349, *Sept.*, 1933.—It has been shown previously by the author that, from the physical point of view, the process of propagation of the nerve impulse is essentially different from the propagation of other kinds of disturbances usually studied in physics. Instead of being described by a differential equation, this type of propagation leads to a simple integral equation. In the domain of the inorganic similar types of propagation are met in the spread of activation on the surface of passive metals. In the present paper the problem of such types of propagation is treated mathematically for two different cases. In the first case it is assumed, that the nerve is electrically uniform all along its length. In this case the final formula for the velocity of propagation reduces to a rather simple expression which, applied to the ischidiacus of the frog, leads to a value of 15 m. per sec. for the velocity of propagation. In the second case the nerve sheath is assumed to be completely insulating, except at the Ranvier nodes, where its continuity is broken, so that the electrical properties of the nerve vary periodically along its length. For the second case a more complicated formula is obtained, which reduces to the first one, when the distance between the nodes tends to zero. Effects of possible distributed capacity are briefly discussed. AUTHOR.

4688. X-Ray Stereoscopy. H. R. Jarre and O. E. W. Teschendorf. *Radiology*, 21. *pp*. 139–155, *Aug*., 1933.—Mention is made of the over-valuation which is often placed upon the stereoscopic 3-dimensional visualisation of radiographs and the impossibility of stereoscopic appreciation by persons of monocular vision. The factors which are involved, such as ocular accommodation and convergence are discussed, as well as secondary factors, in which great differences arise as respects photographs and radiographs. The technical considerations of X-ray stereography are considered, in conjunction with stereographic X-ray viewing apparatus due to Hasselwander and Beyerlen, together with causes of distortion and various factors which are involved. Telestereoscopic distortion is illustrated in respect to various radiographs of the skull. The author is of opinion that, if the Hasselwander stereoskiagraph and the Reaves radiographscope could be combined, this would result in an ideal instrument, and technical suggestions are offered in this respect. Attention is directed to a work upon X-ray stereoscopy by Cohn and Barth. B. J. L.

4689. Transmission of Infra-Red Radiation Through the Horny Layer of Human Skin. A. R. Pearson and R. E. Norris. *Brit. J. of Radiology*, 6. *pp*. 480–486, *Aug*., 1933.—The experiments described are an extension into the infra-red of absorption measurements previously made in the visible and ultra-violet regions. After dispersion in a Hilger constant deviation spectrometer, with fluorite prism, the radiation is allowed to fall on the specimen of skin and is measured by means of an evacuated thermopile. Errors due to diffusion of the radiation and unwanted heat conduction are to a large extent eliminated. The Stratum Corneum shows strong absorption bands with maxima at about $3 \cdot 0$ to $3 \cdot 1\mu$, which is characteristic of the alcoholic hydroxyl group, and at about $3 \cdot 4$ to $3 \cdot 5\mu$, characteristic of C-H vibrations. A number of minor bands are found at $1 \cdot 7$ and $2 \cdot 3\mu$, attributable to C-H, and at $0 \cdot 96$, $2 \cdot 0$ and $4 \cdot 7\mu$, corresponding to liquid water. A series of parallel experiments with cellophane are included. J. E. R.

4690. Influence of Filtration on Surface and Depth Intensities of 200-kV X-Rays. Edith H. Quimby and L. D. Marinelli. *Radiology*, 21. *pp*. 21–29, *July*, 1933.—In early X-ray therapy at comparatively low voltages, to obtain homogeneous radiation, on the assumption that homogeneity is shown by a straight line when absorption is plotted with a semi-logarithmic scale, filters of low absorptive power, such as aluminium and glass were used. As higher X-ray voltages were used, it became necessary to filter by metals (or alloys) of higher atomic weight. In order to increase the depth dose, higher filtration was used, but, for a small increase of depth dose, much longer times of irradiation were necessary, with economic disadvantages, *i.e.*, fewer patients could be treated in a given time. Practically two standard filters were established, 0·5 mm. copper if rapid treatment was necessary, or 2 mm. copper when the time factor was not so important. Thoraeus, in 1928, recommended an alloy filter of given percentages of tin, copper and aluminium, allowing greater depth dosage. The present paper is intended to investigate the surface and depth doses of various filters, as used in therapeutic practice. Such dosage depends on the target-skin distance, and the area of irradiation, in addition to the actual filtration. To supply the X-rays a Coolidge tube operating at 200 KV and 30 MA, with mechanical rectification was used. Precise details are given of the ionisation measuring apparatus used, and the results are shown by curves and tables. The relative amounts of radiation transmitted by the filters, at the surface of the absorptive medium (water phantom) was found to be the same. At greater depths of the water absorptive medium, heavier filters showed higher intensities, but there was no marked gain before a depth of 10 cm. With heavy filtration, longer times of irradiation are necessary, and it is found it is more advantageous to increase the target-skin distance, rather than to use a heavier filter, as the necessary increase of time is smaller. The depth dose in water is correlated with the half-value layer of copper, and a scheme is offered by which the depth dose for any radiation, within the range of the present experiments, can be obtained if the copper half-layer value is known. As outside the present investigations it is mentioned that there is evidence that shorter wave-length radiation, obtained by medium filtration, may have a greater therapeutic value, than that obtained by heavy filtration.

B. J. L.

4691. Standardisation of X-Ray Dosage by Means of Methylene Blue. W. Stenstrom and Anne Lohmann. *Radiology*, 21. *pp.* 29–36; *Disc.*, 36, *July*, 1933.—Ionisation measurements, in relation to X-ray dosage, can be very accurately carried out, but the objections are that the procedures are very involved, calling for a skilled physicist, and the measurements are often impossible in situ, owing to practical therapeutic requirements. Some simple chemical method of dosage measurement would obviously offer great advantages in these respects. The author details the requirements of a suitable chemical method, and, in spite of pitfalls, believes that a properly prepared solution of methylene blue, may fulfil the practical requirements. The solution has to be very carefully prepared, and the following factors are discussed in detail; the determination of concentration, the effect of impurities, and the change of sensitivity with age of solution. Comparison of the authors' practical results are discussed in relation to ionisation measurements, but it is pointed out, even with ionoquantimeters, of more simple type than the standard instruments, errors can occur. It is suggested that methylene blue solutions can be used in clinics and returned to a central laboratory for more accurate spectrophotometric estimation. This would allow an apparatus to be calibrated say at periods of one month, instead of over a much longer interval. The use of the solution, when exposed at different depths, would permit estimation of the penetrability of rays. In the *Discussion*, **Taylor** commented upon the fact that this method, unlike the introduction of an ionisation air chamber, does not result in disturbance of the absorption of the medium as a whole. B. J. L.

4692. Advantages and Disadvantages of Large Chamber Measuring Apparatus. A. K. Merchant. *Radiology*, 21. *pp.* 123–125, *Aug.*, 1933.—An ionisation chamber, larger than 2 or 3 c.c. in volume, is too large for dosimetric measurements with the patient in situ. The author has had experience of ionisation chambers of volume 20 to 300 c.c. The advantages are that the large ionisation current allows the use of a robust microammeter, or alternatively, a galvanometer, so that leakages and field distortions are avoided, and a large chamber may be built so as to measure the intensity and dosage directly. Lack of portability and inability to utilise the apparatus directly upon the patient's skin, are the disadvantages of large ionisation chambers. Measurements carried out by means of a chamber formed by a bakelite cylinder 11 cm. in diameter and 25 cm. long, filled with water are reported, and comparative results were obtained by immersing an ionisation chamber of the small type in the large ionisation chamber. The need of actual biological measurements, as contrasted to physical measurements, is expressed, and *Dropsophila* eggs appear to offer a suitable mode of investigation in this respect. B. J. L.

4693. X-Ray Output Comparisons of Therapy Circuits and Tubes. M. J. Gross and Z. J. Atlee. *Am. J. of Roentgenology and Radium Therapy*, 36. *pp.* 229–233, *Aug.*, 1933.—A short paper, chiefly of data and curves, relating to comparative tests upon 8 different types of air- or water-cooled X-ray tubes, when excited by h.t. energy obtained from a mechanical rectifier, a half-wave valve rectifier, a full-wave valve rectifier, a condenser (voltage doubling) valve circuit, a condenser (voltage tripling) valve circuit and a constant potential (voltage doubling) valve circuit, according to schemes of connection which are illustrated. Other factors of possible irregularity such as the aerial system, methods of dosage measurement, instruments, etc., were avoided by the use of a common method of investigation. No significant differences of dosage output, greater than 5 % were noted between the mechanical rectified, or half-wave, or full-wave valve rectified circuit, and any differences in this respect hitherto noticed are attributed to difference of equipment. Differences were, however, found to occur in respect to whether the tube was air or water-cooled, but differences of glass absorption, intrinsic to the tube, may be the cause of these variations. B. J. L.

4694. Effect of γ-Rays on the Metabolism of Tissues in Culture. Barbara E. Holmes. *Brit. J. of Radiology*, 6. *pp.* 461–467, *Aug.*, 1933.—With a view to elucidating the problem of the type of injury received by a cell during exposure to X-rays and γ-rays, some aspects of the metabolism of cells after such irradiation are studied. The cultures investigated were from embryo rat kidney tissues, and the experiments are restricted to the effects of γ-rays on the nitrogen or protein metabolism and the carbohydrate metabolism. It is shown that 14 hours irradiation from 300 mg. of radium screened by 0·5 mm. platinum at a distance of 0·5 cm. inhibits the utilisation of glucose by the culture during the first two days; the amount utilised may decrease by as much as 60 %. The area of outwandering of the cells from the culture and the gross appearance of the cells during the first two days is hardly altered by the exposure to

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γ-rays. The nitrogen metabolism is probably unaltered by the exposure and is clearly less sensitive than the carbohydrate metabolism. J. E. R.

4695. Viscosity Changes Produced in Protoplasm by Radiations from Radioactive Substances. Nora Feichtinger. *Naturwiss.* 21. *pp.* 569–575, *Aug.* 4, *and pp.* 589–591, *Aug.* 11, 1933.—The paper describes investigations which show that relatively weak irradiation results in a lowering of the viscosity of protoplasm, while relatively strong irradiation increases the viscosity. The observed differences between the effects of the three types of rays is not attributed to any specific property of the rays, but to the amount of energy absorbed in a certain volume. The action is probably dependent only on the number of ions produced in the protoplasm. W. E. P.

OSCILLATIONS.

4696. String Controlled A.C. Source. L. H. Stauffer. *Rev. Sci. Instruments,* 4. *pp.* 483–485, *Sept.,* 1933.—This paper describes a device for generating a.c. of variable frequency (50 to 1000 ∼). It consists of a stretched steel wire, the vibrations of which are maintained by an electromagnet. Vibrations from the wire are impressed upon a carbon disc modulator of special design. Modulated current from a battery is amplified and part of it is then used to maintain the wire in vibration while the remainder is fed into an output filter. The harmonics produced are fairly weak and are suppressed with the aid of a simple filter. Advantages of the device are simplicity, continuous frequency control, and ease of calibration. Other applications of the apparatus are described. AUTHOR.

4697. Resonance Frequency of Two Coupled Oscillating Circuits. W. Fehr and K. Kreielsheimer. *Zeits. f. techn. Physik,* 14. 8. *pp.* 306–308, 1933.—The resonance frequencies of a system formed by two equal coupled circuits is considered in relation to the characteristic frequencies of the components. A new method of frequency analysis is introduced showing how the resonance frequency depends on the coupling inductance or coupling capacity. H. M. B.

4698. Metallic Reflection. Part IV. Electric Waves on a Curve. I. Ebeling. *Zeits. f. Physik,* 83. 9–10. *pp.* 669–683, *July* 6, 1933.—In a Lecher-wire system, part of which is rectilinear and part curved, it is found that the wave-length impressed by the electrical oscillations is several times greater over the curved part than on the straight, while the period of oscillation is just as great in a mixed system of this sort as in a purely linear system. As the speed of the waves over a straight path is equal to the speed of light, it would appear that the speed over the curve is several times greater than the velocity of light. This discrepancy is explained by the fact that while the signal speed and phase speed are the same over the straight wires, this is not true over the curve. The paper discusses the phenomenon and describes various experiments in which it was investigated. [See also Abstract 983 (1930)]. W. D. W.

See also Abstract 4707.

PHOTOELECTRICITY.

4699. Influence of the Metal Surface on the Position of the Selectivity in the External Photoelectric Effect. F. Hlučka. *Zeits. f. Physik*, **84. 5–6.** *pp.* **364–366,** *July* **31, 1933.**—It is shown that the selective photoelectric maxima of metals, even with changed conditions at the metal surface, which have as consequence a great change of the photoelectric sensitiveness or shifting of the so-called long wave boundaries, preserve their spectral position. J. J. S.

4700. Selective Behaviour of Alloys with the External Photoelectric Effect. F. Hlučka. *Zeits. f. Physik*, **84. 5–6.** *pp.* **367–369,** *July* **31, 1933.**—An additive behaviour of the photoelectric selectivities of alloys is pointed out, which is observable even with small percentage mixtures. Particulars are given for brass, bronze and tin solder ($\frac{1}{3}$ Sn $\frac{2}{3}$ Pb). J. J. S.

4701. External Photoelectric Effect in Alkali Halides. R. Fleischmann. *Zeits. f. Physik*, **84. 11–12.** *pp.* **717–721,** *Aug.* **21, 1933.**—Through irradiation of ultra-violet light of wave-length under 200 $m\mu$—there arises in alkali halides (especially KBr) a new light absorption region that can be observed with help of the external photoelectric action. This newly produced light absorption can be removed again by heat and absorbed light. J. J. S.

4702. Emission of Electrons from Tungsten and Molybdenum under the Action of Soft X-Rays from Copper. J. Bell. *Roy. Soc., Proc.* **141.** *pp.* **641–651,** *Sept.* **1, 1933.**—The photoelectric emission from molybdenum and tungsten under the action of soft X-rays from copper in the voltage range 1 to 20 kV is investigated. The final curves for the clean metals after heating at high temperatures are given; the photoelectric emission increases regularly with increase of X-ray exciting voltage throughout the range studied. The effect of heat treatment is also dealt with; heating may produce either an increase or a decrease in the photoelectric emission depending on the previous treatment of the metal, but relative values for molybdenum and tungsten are not much affected by heat treatment. The emission from molybdenum is about 70 % that from tungsten. Experiments with an absorption screen of aluminium, 0·02 mm. thick, show that the photoelectric emission is produced mainly by the very soft components of the radiation. AUTHOR.

See also Abstracts **4444, 4665.**

PIEZOELECTRICITY.

See Abstract **4645.**

THERMIONICS.

4703. Test of the Classical "Momentum Transfer" Theory of Accommodation Coefficients of Ions at Kathodes. K. T. Compton and E. S. Lamar. *Phys. Rev.* **44.** *pp.* **338–344,** *Sept.* **1, 1933.**—On the classical theory of momentum transfer at impact of a moving particle with a stationary particle, Compton has suggested that the accommodation coefficient for positive gas ions striking a metal kathode should be less than unity only if the mass of the metal atom exceeds that of the gas ion. To test this hypothesis, momentum experiments of the type already reported for helium ions striking a molybdenum kathode have been continued for

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argon ions striking molybdenum and aluminium, respectively. From the experimental data the accommodation coefficient (α) for the positive ions and also the fraction of the current carried by electrons at the kathode were calculated. The value found for α for argon ions on molybdenum was 0·8, in good agreement with the value obtained by Compton and van Voorhis by thermal measurements. For argon ions on aluminium α was found to be unity, in accordance with the above hypothesis. Three types of impact of ions are analysed and the experimental values of α are shown to conform sufficiently closely to the predictions of the analysis to indicate that the phenomena of loss of energy and momentum are at least approximately described by the postulates of this analysis. A. W.

4704. Work Function and Distance between Atoms. W. Distler and G. Mönch. *Zeits. f. Physik,* 84. 5–6. *pp.* 271–275, *July* 31, 1933.—The work functions are determined thermionically for iron and nickel, the respective values 4·04 and 4·63 volts being obtained. Considered in relation to the values for other metals, the value here obtained for nickel satisfies the formula of Schottky, according to which the work function is inversely proportional to the distance between the atoms. On the contrary the value for iron determined here, unlike that obtained by Siljeholm, does not lie upon the Schottky curve. Comparison of the experimental results with the requirements of the various theories which have been put forward leads to the conclusion that no one of these theories can be considered more satisfactory than the others. L. A. W.

4705. New Method for Determining the Thermionic Work Functions of Metals and Its Application to Nickel. G. W. Fox and R. M. Bowie. *Phys. Rev.* 44. *pp.* 345–348, *Sept.* 1, 1933.—A new procedure for determining thermionic work functions of metals has been developed. The metal sample is in the form of an approximate sphere and is heated by electron bombardment from an auxiliary filament which is disconnected when measurements are made. Electron emission from the cooling sample charges a condenser which, at predetermined times, is discharged through a ballistic galvanometer. Temperatures are determined by a Pt, Pt + 10 % Rh thermocouple spot-welded to the sample. The thermionic constants are obtained from the equation :

$$\log_{10} (\mathrm{T}^2/\mathrm{SQ}) = \log_{10} (2\cdot 3/a\mathrm{A}) + \Phi/(1\cdot 988 \times 10^{-4}\mathrm{T})$$

where Q is the quantity of charge yet to flow upon cooling the sample from a given temperature to absolute zero and − S is the slope of the log Q *vs.* time curve. This equation is derived from Richardson's. The values of the thermionic constants obtained by applying this method to the case of thoroughly outgassed nickel are found to be $\Phi = 5\cdot 03 \pm 0\cdot 05$ volts and $\mathrm{A} = 1\cdot 38 \times 10^3$ amp./cm.^{2} deg.^{2}. AUTHORS.

4706. Effect of Temperature on Field Currents from Tungsten and Molybdenum. A. J. Ahearn. *Phys. Rev.* 44. *pp.* 277–286, *Aug.* 15, 1933.—Electron field currents from the central portion of long molybdenum and tungsten filaments about $2\cdot 7 \times 10^{-3}$ cm. in diameter have been studied. They were first made stable to about 5 % by long-continued conditioning treatments of temperature and high voltage under high vacuum conditions. Thermionic emission measurements gave the values 4·32 and 4·58 volts for the work function of the molybdenum and tungsten, respectively, in good agreement with the accepted values for the clean metals. Emission measurements were then made at fields varying from about 5×10^5 volts/cm. to about 1×10^6 volts/cm. and at temperatures varying from 300° K to about 2000° K. Down to about 1600° K the thermionic currents completely masked the field currents. Thermionic emission values below 1600° K were obtained by extrapolation. Thus the field currents at the lower temperatures were separated from the thermionic currents. Where necessary, corrections were made for the decrease in the voltage gradient accompanying the thermal expansion of the filament. The field currents were found to be independent of temperature to within 5 % from 300° K to 1400° K. At temperatures higher than 1400° K the data are consistent with the assumption that the current consists of a thermionic current plus a current which is independent of temperature. However, because of the exponential change of thermionic current with temperature a small effect of temperature on the field current could not be distinguished at temperatures higher than 1400° K. From the theory of Fowler and Nordheim, β, a factor introduced by surface irregularities, is found to be 120 for the tungsten kathode and 47 for the molybdenum one. Thus for tungsten, Houston's theory of the temperature effect is in approximate agreement with the negative results of these experiments. AUTHOR.

4707. Limitation in Currents of Positive Alkali Ions of Homogeneous Velocities. P. Keck and L. B. Loeb. *Rev. Sci. Instruments*, 4. *pp*. 486–490, *Sept*., 1933.—In endeavouring to obtain an intense source of positive K ions for the study of the radiation potential of K ions in A, a source was developed in which an atomatic beam of K atoms was projected against a Pt strip filament at 1000° C. in high vacuum. The resulting positive ions were accelerated by a field and yielded 2×10^{-4} amp./cm^2. at 330° at a potential of 340 volts, of which about 60 % had an energy distribution of less than 25 volts. The limitation of the homogeneity of the beam lay in part in collisions with atoms in the accelerating field and doubtless can be improved. The space charge limitation of the currents precludes the achievement of greater current densities at these potentials. It is possible that the device could be utilised in the study of the radiation potentials although the recently published method of Dempster and Holzer appears more suitable. Since Li is ionised quantitatively by impact with a hot filament, the device could be utilised in conjunction with a positive ray analyser to separate the Li isotopes at the rate of at least 0·13 mg. per day. It could also be used as a triode for the production of oscillations.

AUTHORS.

THERMOELECTRICITY.

4708. Correlation of Thermoelectric and Thermomagnetic Data. L. F. Bates. *Phil. Mag*. 16. *pp*. 657–672, *Sept*., 1933.—The magnetic properties of some rods of manganese arsenide, prepared for the investigation of the thermoelectric properties of the substance, have been examined. It is found that each specimen which has not been heated since its preparation is ferromagnetic up to a temperature of about 45° C. Such a specimen exhibits a series of changes in its magnetic properties following each transition from the ferromagnetic to the paramagnetic state, until a steady condition is reached. The changes consist of a progressive increase in the intrinsic magnetisation and a progressive lowering of the ferromagnetic Curie point. They are intimately connected with corresponding changes in the thermoelectric power of the substance previously recorded. They are interpreted on the basis of an interaction between the spin moment of one atom and an orbital moment of another. AUTHOR.

See also Abstracts 4632, 4667.